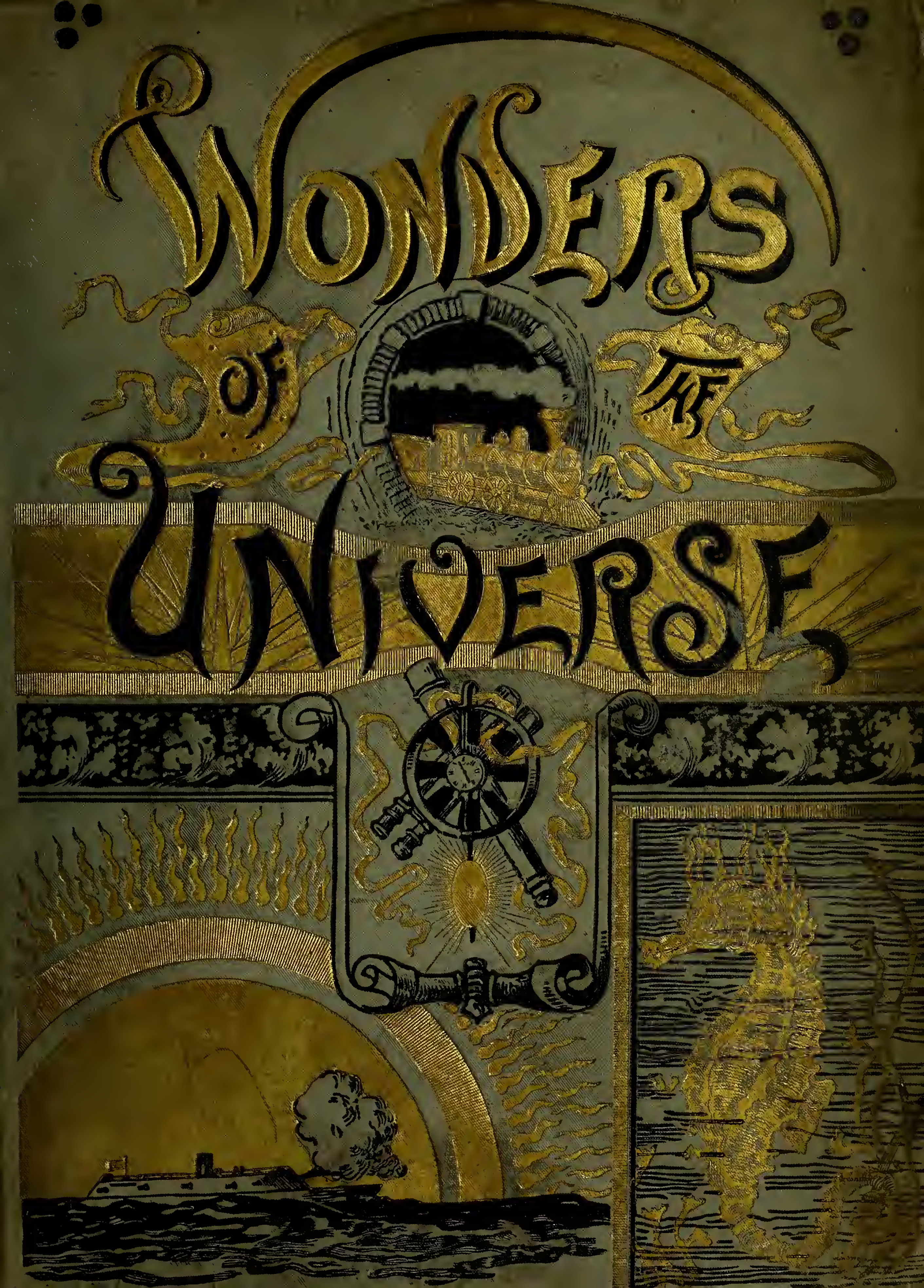
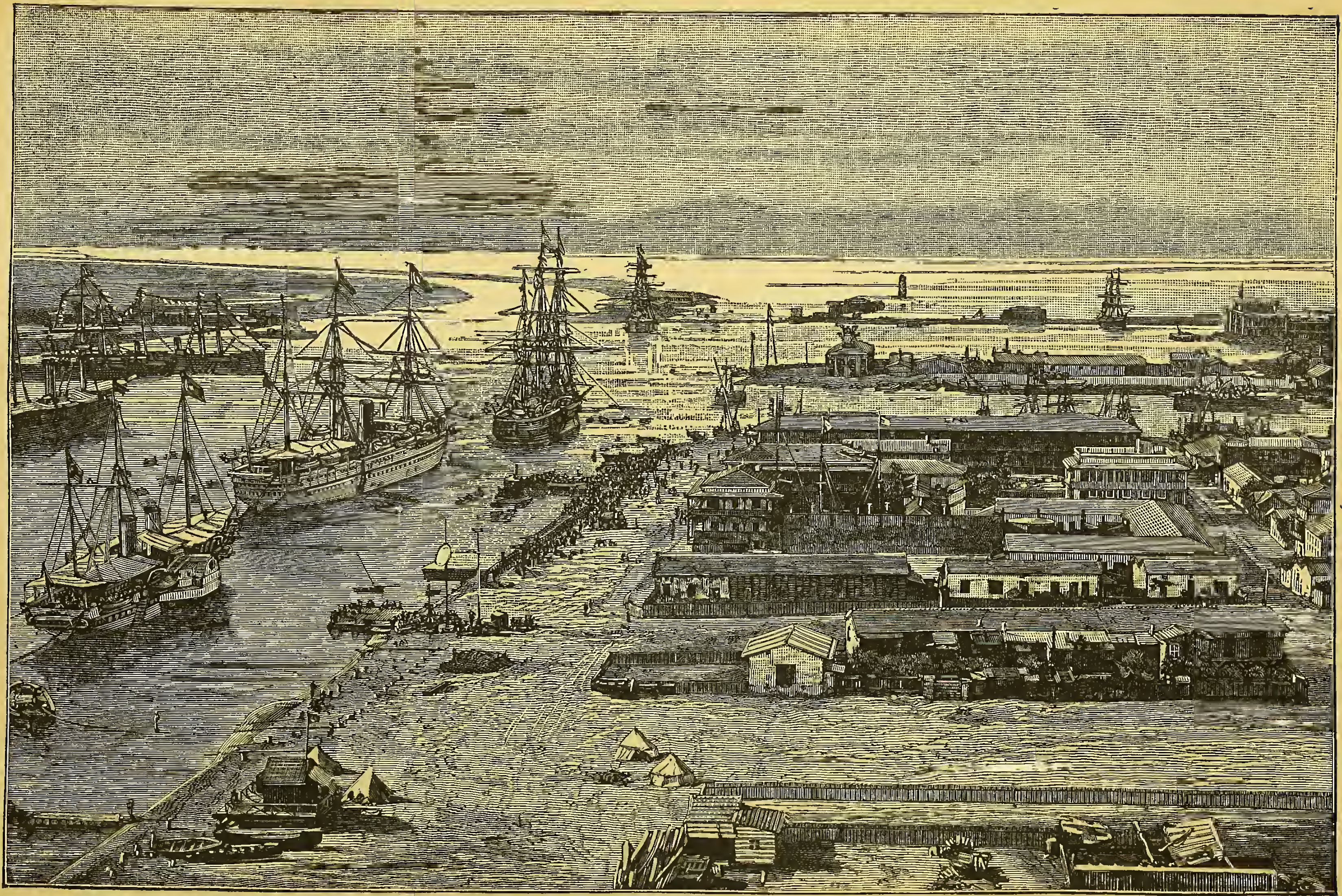

Wonders of the Universe



PORT SAID, THE NORTHERN ENTRANCE TO THE SUEZ CANAL.

THE

WONDERS OF THE UNIVERSE

A RECORD OF

Things Wonderful and Marvelous in

NATURE, SCIENCE AND ART.

INTRODUCTION

By CHARLES BARNARD.

"What does Philosophy impart to man
But undiscovered Wonders? Let her soar
Even to her proudest height—to where she caught
The soul of Newton and of Socrates—
She but extends the scope of wild amaze
And admiration."
Henry Kirke White.

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INTRODUCTION.

There are two ways of looking at things. You may look at a strange bird, a curious insect or some new piece of machinery and say, " Oh, yes ! Very queer, wonderful, and all that," and pass on in search of the latest returns from the base ball match, the last novel, or the opinions of the City Correspondent as to what is going to be worn this season. You can see these things and pause in wonder saying, " Why were they made ? what are they for ? where can I learn more about them ? " Some people having eyes see not at all, and the marvels of modern science, art and invention pass before them as a pretty show having no meaning. Others with curious eyes survey all nature and art in eager haste to know, to understand and to learn.

There is much talk in these days of culture, and people run about seeking the society of cultivated men and women. Who are they ? Who are these cultivated people of whom we hear so much ? Why, even the men and women who affect to despise it, and who think it rare wit to spell culture with a k, secretly admire it, and, if brought into the society of really cultivated people, are charmed and gratified, and take pride to themselves on their good fortune in knowing such people. The cultivated man or woman is one who knows. It is not one who knows a great deal about one thing and nothing else. It is not the woman, slatternly in dress, with inky fingers and verses in the " Poet's Corner " in the evening paper. It is not the old gentleman who is posted on every insect in the fields and who is in debt to his grocer, because he cannot earn a living. It is not the young man with unkempt hair who plays the organ so sweetly on Sunday and who cannot calculate the interest on a three months' note. It is none of these or those like them. Every man and woman must know one thing well, must be well posted in the art, trade or business whereby they keep the wolf from the door. All that is expected as a simple matter of course. To be cultivated means, much more. It means to know something more than the details of one's trade. Every man must, as Emerson says, have his vocation and his avocation. Have your business and add to it some science, some art, some study that is an aside to business. This is to be cultivated—to know something of many things, to be an " all round " man or woman.

When we meet cultivated people we find they can talk intelligently about many things. Bring up any subject, music, art, electricity, physics, farming, business, what not—and they listen to learn and speak with understanding. You may wonder how they came to know so much about so many subjects. How many years did they spend in schools to obtain so much ? Very likely they will say they had very little schooling and went to work at sixteen to earn a living. How, then, did they do it ? The answer is simple enough. Reading. They observe, they look about and see the world and find it full of wonders, and they at once look up some book that will tell them about these things, that will explain these wonders. It is this that makes the educated man or woman ; reading. They see some strange bird and they look up its name and learn its habits. They see an insect they never met before, and, instead of idly wondering about it like a silly child and then turning ignorantly away to read the silly newspaper, they take down the dictionary or the encyclopedia and get a few ideas concerning the creature and his life history. They do not attempt to know every detail of its habits, nor do they commit to memory the names of all its parts. That is useless, because it is an unessential detail. They look only for general information that will give them the chief facts about the creature, his name and native country, and the order or class to which he belongs.

Every art, science, trade, manufacture and profession has its general principles, its main facts. What is needed is to know these, and to leave the details to those who make a special study of the subject. Take, for example, electricity. It is, at first sight, a very complicated science, and yet it is really very simple. It is a science that is becoming of greater use every year, and enters largely into social and business life. To be ignorant of its few simple laws is to expose one to all the tricks of the mountebank on the street corner, who tells you "electricity is life," for five cents a shock, or the quack who sells you electric plasters or tooth brushes. Electricity cannot do every thing. It really does very little, and nothing at all alone and of itself. It is only a means of doing things in a superior way. A water-fall runs to waste with much roaring, fury, foam and mist. A man of science puts in a turbine, and whole streets are lighted up with brilliant electric lights. It is the water-fall that lights the town—electricity is merely the means whereby the power of the falls appears as light in the lamps. The uncultivated young person flits along the way, glad the brilliant light offsets her dress so nicely, ignorant and careless why and how it happens her ribbons are so much more beautiful in the new light than in the gas lamps of the ball room. The cultivated man sees in the dazzling light the latest and most wonderful advance of science applied to the comfort and well-being of men and women.

Let us understand this matter clearly. The old monks, who formerly held in selfish mystery all the learning of the world, feared that if knowledge and learning were suffered to go out among the people they would be maltreated and lost. We know now that this was all a mistake. All knowledge, all science, all learning and art are for all the people. The man of science has no secrets. His culture is for the helping of men and women and little children. The student now learns that he may teach the people. The sciences are not mysteries. They are easily understood, as far as their main principles are concerned, by any intelligent young man or woman. Let no man think he cannot study because it takes a lifetime to become a master. Why be a master? We may do that in our daily vocation, but for these other things, these arts and sciences, what we need is to be students and observers of general principles. We only need to know the great laws of all sciences to be fairly educated in all. It is this that makes the educated man or woman. To know something of many things.

It is with this view this book has been prepared. The aim has been to take some of the *Wonders of the Universe* and to make their grand general principles clear to all who can read. Notice the word *Universe*. Formerly men were content to study the things in their own land, and to be ignorant of every thing in other lands. In time this narrow view gave place to a wider outlook over the world. Then it was discovered that the world is everywhere alike, that the laws of nature are the same on one continent as on another. This led to a wonderful broadening of ideas. Men of science became citizens of the world, instead of being Frenchmen, Englishmen, Germans or Americans. The railroad and steamship brought all people together, and now the wonder is not that the world is so big, but that it is so very, very small. Then came the last and most remarkable change. It was found that the elements of which this little Earth is formed exist in the Sun and in the most distant star. If we find hydrogen burns here, we no longer wonder to find flaming hydrogen so far away in the starry depths that we have no figures to express the distance at which those pale fires are burning. So our view spread to the Universe, and we found that true culture includes the Universal. So, by slow steps, science grew up from the small to the great, from the study of stones to the study of the globe, from the Earth to the Solar System, and from this little group of stars to the illimitable Universe. To be cultivated is to read of these things, to know the why, the way and the end to which all these laws of nature tend, to see that a Universal Mind pervades all things, from the infinitely little to the infinitely great, and this Universal Mind we have called God.

In the UNIVERSE OF WONDERS one science has been treated in detail. This is electricity, and the reader is advised to try as many of the experiments as possible. If the apparatus cannot be obtained, try and make it for yourself out of materials in the house. For instance, a very good electroscope, see page 23, can be made of a wide-mouth pickle jar, by taking a piece of stiff copper wire, bending one end, for about an inch, at a right-angle, and rolling up the other end into a round knot. Bore a hole in a cork that fits the jar, and let the bent end of the wire hang in the jar with the top projecting above the cork. Hang on the lower end a little strip of Dutch metal and you will have an electroscope answering just as good a purpose as one costing two or three dollars from the instrument makers. For an electrophorus get a thin disc or circular piece of common hard rubber or vulcanite and tack it to a block of wood. At the tin-man's get a disc of common tin-plate, a trifle smaller than the rubber disc. Take a piece of sealing-wax, and setting fire to the end of the stick, press it while burning against the centre of the tin-plate, and it will stick fast and form an insulated handle for the electrophorus. Then rub the rubber disc with a flannel rag or pad, and lay the tin plate on it. Touch it quickly and gently with the finger, and then raise the plate by the wax handle, and on presenting the knuckle to the plate a little electric spark will flash to the hand. By warming the vulcanite over a stove and performing the experiment in a dry, warm room, a great number of sparks can be taken in succession from the tin-plate. To make a Leyden Jar, cover the bottom and sides of a tumbler to within an inch of the top with Dutch metal or tin foil, fastening it to the glass with flour paste. Cover the inside of the tumbler in the same way, and then get a piece of stout copper wire, roll up one end into a ball or round top, set it upright inside the tumbler and fasten it to the foil with sealing-wax. These are only hints of what can be done, and with a little ingenuity many interesting electrical experiments can be performed at home, with home-made tools. It is always best to perform experiments in every science, because every experiment will teach more than can be told in any printed description of the experiment or its results.

Besides these descriptions of the Sciences there will be found in the book many strange and curious things concerning insects, fishes, and the minute plant and animal life that swims or grows unseen in a drop of water. There are also accounts of strange habits and customs among different barbarous and savage peoples, that are interesting because they are passing away. Science tends to make all men alike by showing all peoples that they are really brothers in the great Human Family. This in turn tends to remove and destroy the differences between races. Costumes and national habits and manners disappear before the spread of civilization, and in time the dress and manners of the English and American will become the manners and dress of the Universal Man. Distinctions of race slowly fade, and when they have gone national differences will follow, and then we shall be neither Englishmen nor Americans, but citizens of the World. So these passing and fading traits of barbarous peoples are wisely preserved here beside the modern sciences as mile-stones along the path of Civilization.

CHARLES BARNARD.

INDEX.

The asterisk (*) denotes that the Article is accompanied by one or more illustrations.

LIST OF SEPARATE PLATES.

We are passing from the age of Steam into that of Electricity ; and the change expresses a great deal, the meaning of which is only beginning to be fully understood. It may be said, however, that the extraordinary advances made, through patient observation and experiment, in our knowledge of the secrets of Nature, have had two principal effects upon the imaginative faculty. On the one hand, what were once called "marvels" have largely ceased, merely as such, to excite the same vulgar wonder as formerly in the human mind. But on the other hand, it is felt more and more that the whole world around us, and what we have called "natural" forces and phenomena, are themselves crowded with marvels such as our fathers never imagined. This is not only true of the infinitely great, but of the infinitely little. The smallest portion of the commonest Matter, which we can take up between our finger and thumb, is found to present problems full of profound mystery and wonderful fascination ; and as we even begin to learn something of these, we are overwhelmed with wonder at the whole world of marvels in which we dwell.

In commencing at this date an entirely new volume of THE WORLD OF WONDERS, it is both necessary and proper to seek that it should reflect something of this change in the disposition of human thought and marvel. To explain some of the leading features of Nature's own WORLD OF WONDERS will therefore be the main task undertaken in the present volume, though at the same time not excluding such lighter articles and items of curious intelligence as may be likely to interest the reader.

The wonders of ELECTRICITY will necessarily have a prominent place in these pages. So much progress has been made in this particular direction, as almost to amount to a revolution in our practical relations to this marvellous force ; and a complete series of popular articles has therefore in this case been arranged, in order that the subject may be brought up to the present state of knowledge. The wonders of the Telephone and Microphone will be explained, and those marvellous "dynamo machines" at which so many have stared will be popularly elucidated ; as will also the varieties of Electric Light, and the applications of the same wondrous force as a motive power.

Some endeavour will likewise be made to show how much the wonderful phenomena of Light have done to elucidate the physical constitution of the Universe. Of the immense advances made in spectroscopic science of late years some idea will be given, as also of the mode in which this and other forms of optical study have cleared up many points, not only concerning the far-off orbs around us, but about the humdrum forms of matter which lie nearer home.

Something, too, must be said about this Matter ; which, simple as it looks, is perhaps the greatest mystery and wonder of all. What is it? What are those Atoms and Molecules of which the physicist now speaks? What evidence is there for their existence, how are they counted or measured, and how do they behave? Not the least interesting may be the few chapters in our WORLD OF WONDERS which attempt either to answer these questions, or at least to tell what men of science now believe about these Atoms, and how their behaviour and combinations explain alike the terrific results of a dynamite explosion or the beautiful array of aniline dyes.

But not only from such subjects as these shall we select material for our pages. We shall collect wonders of all kinds from the Earth, from the Sea, from the Sky. We shall find marvels in character, and in other phases of human and animal Life. We shall extract from the stores of what seems at first the unfathomable past. We shall gather up remarkable achievements and striking triumphs of constructive Art. With so much to draw upon, we cannot fail to fill another volume with interesting and instructive material.

And through all—through such wonderful forms of Life as may come under our notice, as well as in the wonders of the inanimate Matter which lies on every hand, and is necessary for even Life itself as we know it here—we shall try to preserve the one great and grand idea which has more and more towered above every other during the last quarter of a century. We shall try to show something of the UNITY OF NATURE ; to point out, though more indirectly than directly, that all these Wonders are no disjointed puzzle, but that even through the darkness there ever looms a stupendous Plan. Not a Chaos, but a WORLD—nay, a Universe—of Wonders, is that of which some brief outlines are to be attempted in the following pages.

THE ROTATION OF THE EARTH.

THERE is an instrument called the Gyroscope, first invented by Bohnenberger, but subsequently much improved by Foucault, the celebrated French physicist. It has many forms, some of which are swung on several systems of complicated gymbals or swing-joints, like those used about a ship's compass ; but the simplest is that now pretty well known as the "magic top," which consists of a small but heavy and accurately-turned fly-wheel truly balanced in the centre of an axis, which turns upon hard conical points screwed into a ring, as shown in Fig. I. The ends of the screws project through the ring; one being usually pointed, and the other furnished with a small smooth knob, which can rest in a small polished cup at the top of a pedestal.

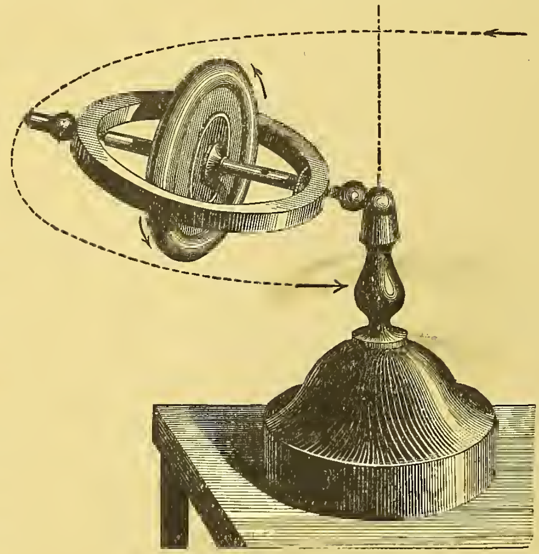


Fig. I.—MAGIC TOP.

By violently pulling a long piece of string coiled round the axis of the instrument, the fly-wheel of this simple Gyroscope can be made to rotate very rapidly; and if the point at one end of the axis be inserted into the cup with the axis vertical, the whole spins just as a common top would do. If, on the other hand, without spinning, the top be placed with the knob in the cup, as shown in the engraving, it will, of course, fall to the table by its own weight. But if, while rapidly rotating, the knob be placed in the cup with the axis either horizontal or inclined, it is not so. The apparatus while thus spinning *resists* even the strong force of gravity, and the top retains its position, even if of several pounds' weight ; the whole slowly revolving round the pedestal, as shown by the horizontal curve, the direction depending upon that of the rotation. It seems like magic, to see a heavy mass of metal apparently thus suspended in air, with nothing to sustain it. Sometimes the spinning portion of the Gyroscope is mounted so as to revolve in a hollow metal ball or shell, with a small hole in it through which to pull the string. In that case, when it is spun and the shell is held in the hand, if the fly-wheel be heavy and the motion quick enough, it is marvellous to feel how strongly what seems a simple round metal ball *resists* any change in the direction of the spinning axis; it seems to push and turn against the hand, when change of position is attempted, like a living thing.

This extraordinary phenomenon teaches us a very important lesson, which it is not so very difficult to understand. We know that all matter is what we call *inert.* If it is still, it cannot move of itself: and if it is in motion, it must *keep on* moving in the very same direction, unless stopped or turned aside by some fresh and overpowering force. We know very well that if the particles of our Gyroscope were loose and free, they would therefore fly off at a tangent when it was rotated, like the drops of water from a trundled mop; but being bound to their axis in one mass, they revolve round it. But the law holds good otherwise: they cannot change their direction unless gravity or some other force is great enough to overcome their momentum, and change the direction of their motion into some other. In a swiftly-rotating body the momentum is very great; and hence comes the wonderful phenomenon we have seen, which physicists call the "fixity of the axis of rotation." Every man who rides a bicycle takes advantage of the very same law.

Now our earth—and all the heavenly bodies too, but we confine ourselves to the earth—behaves exactly like the Gyroscope, and in fact is one, though on a vaster scale; and a great deal of our comfort depends upon its doing so, owing to this general law of rotating bodies. In Fig. 2 we have a diagram of the earth in four positions of its annual orbit. In traversing this orbit round the sun the earth also turns upon its axis, as everybody knows. But this axis is not perpendicular to the orbit, like the perpendicular lines in the diagram. If that were the case, as the reader can easily see with a little reflection, the equator would always pass daily under a directly vertical sun, and the poles would never receive the sun's rays except from the very horizon: both the heat of the tropics and the cold of the polar regions would be enormously exaggerated, and life would be intolerable in all but the temperate zones. Again, we may conceive of the axis of the earth always inclined in one direction towards that of the sun; as it would be if we suspended a ball by a string, tied the other end of the string to the top of an upright pole, and then swung the ball, revolving on the string as an axis, round the pole. If the earth could revolve in this way, we can see that either the north or the south pole would always be partially turned towards the sun, and would enjoy perpetual day at the price of a tropical heat; while the other pole would be condemned to perpetual night, and to a degree of cold of which man has no knowledge or experience. The seasons would again be constant; and, excepting in one narrow zone, would be extreme: the *alternations*, which now make extremes both of heat and cold endurable and even enjoyable, would cease to exist.

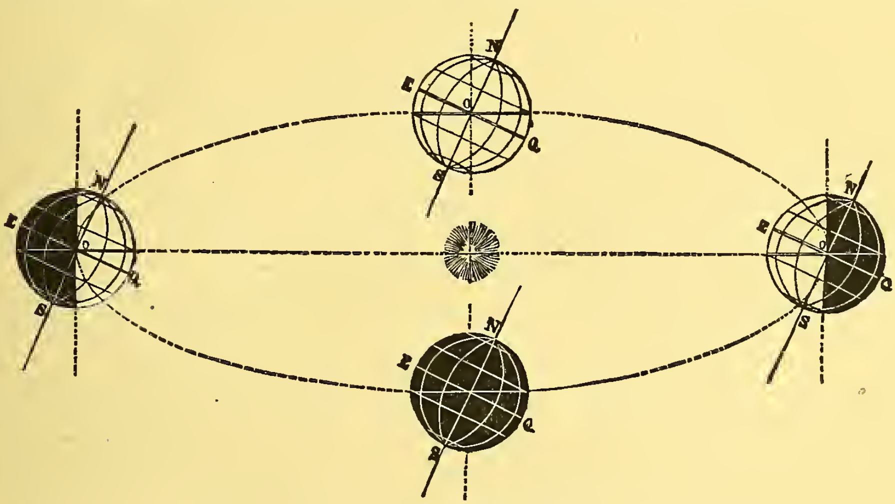


Fig. 2.—INCLINED AXIS OF THE EARTH.

As it is, the earth's axis is inclined in the direction of the lines N S in Fig. 2; and as the great Gyroscope revolves freely in space, the axis always maintains the same direction. The consequence is that the equator E Q, as can be readily seen, only comes under a vertical sun twice in each year, represented by the top and bottom positions; while in the right and left positions the sun is vertical over the northern or southern tropic. Each pole also gets in turn its greater and lesser share of the sun's rays, and its alternate long day and night of six months each; and so this great law of rotation not only ensures the due *alternation* of colder and warmer seasons, but also *moderates* the extremes of each over all the surface of the globe.

Strictly speaking, this "fixity" of the earth's axis is subject to one modification: the axis itself rotates, or "wobbles" a little, very slowly, round the centre of the globe, so that both north and south poles in the course of a very long period of time describe a small circle in the heavens. This causes an imperceptible change in the seasons, known as the "precession of the equinoxes," which can, however, only be detected by acute observations extending over many years, a complete revolution of the axis in this way only occurring once in 25,000 years. The causes of it can only be shown by mathematical analysis; but the phenomenon itself is exhibited by the Gyroscope when properly arranged, being due to the same mechanical reasons.

The fixity of the plane or axis of rotation may be even employed to make the earth's rotation on its axis *visible* to the naked eye. The motion of a pendulum, or the balance-wheel of a watch, may be regarded as rotation in alternate directions round an axis, and is subject to the same laws. A pendulum suspended quite freely will, therefore, maintain the same plane of vibration (*i.e.*, line of swing); and this though its point of suspension be turned completely round. On a piece of board about a foot in diameter let some light arched support be fixed, from which a leaden bullet can be hung as a pendulum over the centre of the board. Lay the board on a music-stool; and, having drawn the bullet to one side, let it swing. If carefully swung the vibration will remain in one plane; and when this is accomplished let the music-stool be turned round. The bullet *will still swing in the old plane*, towards, say, the same corner of the room; and thus, as it crosses different points in the circumference of the circle, it will make visible the rotation of the music-stool. It is easy to see that if a pendulum, large and heavy enough to swing for a whole day, could be thus suspended over either pole of the earth, it must gradually appear to swing round the whole circle, and so make visible the earth's rotation upon its axis in twenty-four hours.

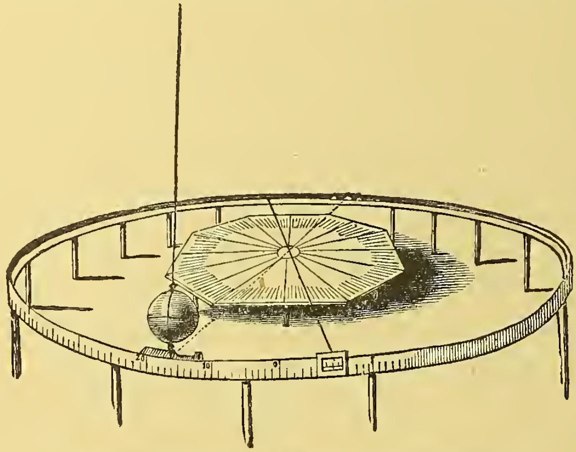


Fig. 3.—FOUCAULT'S PENDULUM EXPERIMENT.

We cannot get at either of the poles; and it is difficult, if not impossible, to get a free pendulum which will swing accurately so long, for a reason immediately to be seen. But it occurred to Foucault that these difficulties did not touch the essence of the question, only making a difference in degree; and in the cellar of his mother's house in Paris he first successfully made the celebrated "pendulum experiment," which immediately afterwards attracted crowds to see it repeated at the Panthéon. A few weeks afterwards the experiment created a similar excitement in London. At the Panthéon the experiments were conducted by Foucault and Arago, and the arrangements were as in Fig. 3, the pendulum swinging over a divided octagonal table, surrounded by a large circle divided into degrees, with a movable index, so that the deviation from any starting-point could be shown. At the Polytechnic similar experiments were conducted by Dr. Bachhoffner, at the Royal Institution by Professor Baden Powell; and they were afterwards repeated at many other places. Some controversy was at first excited owing to somewhat different results; but the reasons of these were gradually traced out, and found to be due to mechanical causes, or the distance of the point of suspension from the earth's pole. Mechanically, it is extremely difficult so to draw aside and release a free pendulum that it may vibrate truly in a plane. The ball must be most accurately turned and equally smooth all round; the wire must be inserted *exactly* central and opposite the point; and finally, the release is a matter of much nicety. Currents of air also affect the swing. And, on the other hand, a very little reflection will show that when the experiment is made anywhere between equator and pole, the force of gravity itself is a disturbing cause. It acts at first to draw down the bob exactly in the line of the original swing; but when the earth has made a quarter-revolution, if the plane of vibration could remain exactly the same, it would not be so: the pull of gravity would be from one side of that plane. Thus gravity itself, except at the actual poles, tends to draw a pendulum slightly but steadily to one side, and thus to convert the straight or plane swing into a curve, and somewhat to diminish the angular deviation of 15° per hour, which a pendulum swung at the actual pole would show. When care was taken to avoid the mechanical causes of error, and the effect of the other deviations was calculated, the results were found nearly to correspond, and the deviation per hour to *increase* *with the latitude*, as it ought to do. An average of several experiments showed that the pendulum ranged in an hour over 11° 30′ at Paris, 11° 42′ at Bristol, 12° at Dublin, and 13° at York.

Our last illustration shows the experiment as performed, in perhaps its most imposing form, at the once-celebrated Polytechnic Institution in Regent Street, London, in May, 1851. A large divided circle, 16 feet in diameter, hollowed out to the swing of the ball, was drawn conspicuously on the stage, and a heavy bob, most accurately turned and smoothed, was swung by a long and carefully-straightened wire from a girder overhead. At the Polytechnic the wire was 45 feet long, and the bob 28 lbs. in weight. A pendulum of this size, when set swinging, kept up good work for over an hour; and during that period—occupied by an interesting lecture, with other experiments illustrative of the same subject—was found to have apparently deviated from its first direction by an average of about 12°, or half a yard on the circle.

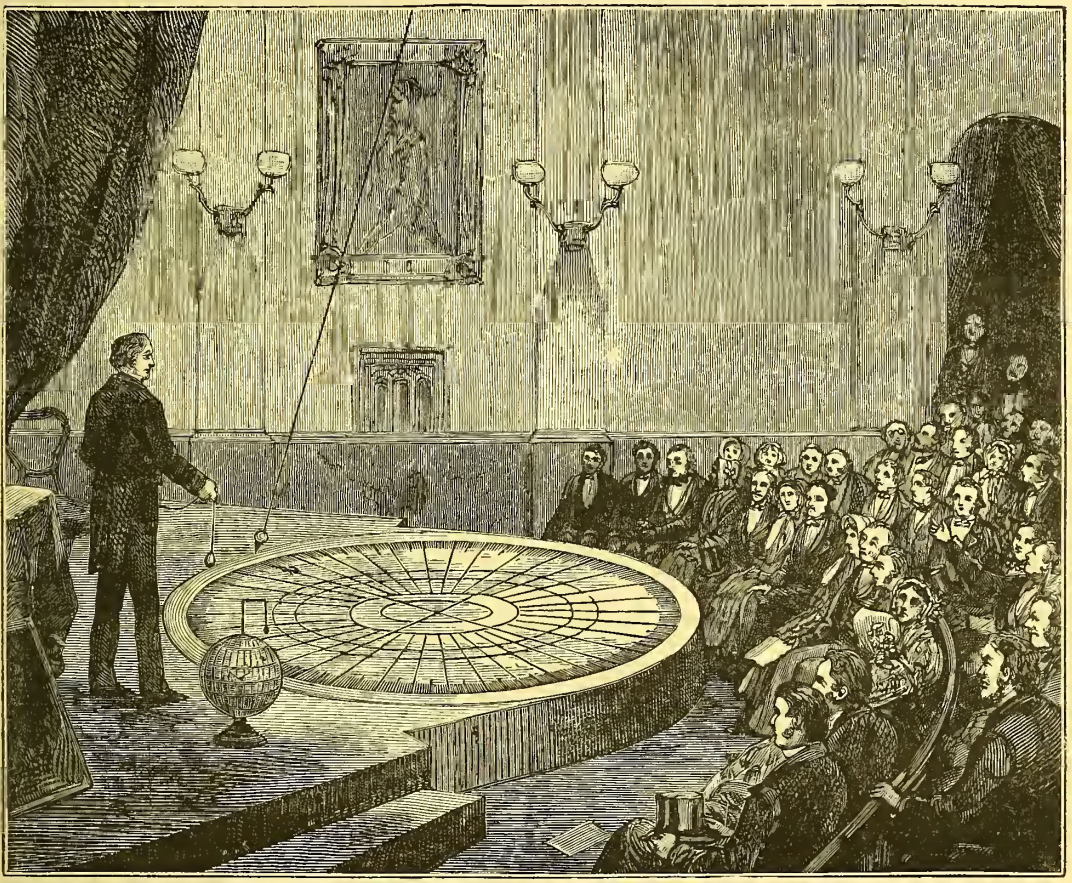


Fig. 4.—PENDULUM EXPERIMENT AT THE POLYTECHNIC.

Thus simply may we see with our own eyes, if we will, the rotation of the earth. And there is one thing more we may learn from this interesting experiment, viz., that the same law of rotation holds alike in its grasp our petty pendulum and the stupendous world on which we live. Ponder either a tiny bullet shot from a rifle, or the grandest globe in the heavens; both must be, and are, governed rigidly by the same laws, and are connected together by them. So it is throughout all Nature. Nothing stands alone throughout the material world, or can escape from the order and harmony which rule the rest.

REMARKABLE DREAMS.

GUISEPPE TARTINI, a famous Italian musician and composer of the last century, had a dream which led to his composition of a piece of music now well known as "The Devil's Sonata." One night in the year 1713 he dreamt he had made a compact with the devil, who promised to be at his service on all occasions. At length he thought he gave Satan his violin, to see what sort of a musician he was; when, to his great astonishment, he heard him play a *solo* so singularly beautiful, and executed with such superior taste and precision, that it surpassed all the music he had ever heard or conceived in his life. He awoke with the violence of his sensations, and instantly seized his instrument, in hopes of expressing what he had just heard, but in vain. He, however, composed the piece which is perhaps the best of all his works, and called it *The Devil's Sonata;* but it was so inferior to what his sleep had produced, that he declared he would have broken his instrument and abandoned music for ever if he could have subsisted by any other means.

Samuel Taylor Coleridge had once an equally remarkable dream when under the influence of an anodyne. The poet had been reading "Purchas's Pilgrims," and when he had finished this passage, "Here the Khan Kubla commanded a palace to be built, and a stately garden thereunto; and thus ten miles of fertile ground were enclosed with a wall," he fell asleep. During this sleep, which lasted about three hours, he composed from 200 to 300 lines of poetry about Kubla Khan's palace and pleasure-grounds. His last waking thoughts affected his sleep, and his poetic imagination conjured up visions of the things he had been reading about, solid and life-like.

Watts, the Bristol plumber, had a dream more profitable than either of the preceding, if we take into account the *£ s. d.* which accrued to the dreamer. As he slept one night in the year 1782, he imagined that he was out in a shower of rain. But curiously enough, the clouds seemed to rain molten lead instead of water, and the drops of lead as they came down were perfectly spherical. When he awoke he was struck with the idea that there was probably here a method of making lead shot. He put the matter to the test, and from the top of the tower of St. Mary Redcliffe Church he poured molten lead into some water below. The plan succeeded well, and he sold the invention for a large sum of money.

Another remarkable dream was that described in the "Philosophical Transactions" for 1748, in a paper by Archdeacon Squire. Henry Axford was the son of an attorney of Devizes, in Wiltshire. Subject to fits up to the age of twenty-five, his health then became good, but, probably in consequence of a cold he received, when twenty-eight years old he became speechless, losing the articulate use of his tongue, and being nearly unable to make the least noise. He soon recovered from his cold, but he did not recover his voice. The rest of the case we may give in the Rev. Mr. Squire's own words:—"He continued in this way dumb for four years, till one day in the month of July, in the year 1741, being at Stoke, in the above-mentioned county, he got very much in liquor, so much that upon his return home at night to Devizes he fell from his horse three or four times, and was at last taken up by a neighbour, and put to bed in a house upon the road. He soon fell asleep; when, as he tells the story himself, dreaming that he was falling into a furnace of boiling wort, it put him into so great an agony of fright, that, struggling with all his might to call out for help, he actually did call out aloud, and recovered the use of his tongue from that moment as effectually as ever he had in his life, without the least hoarseness remaining, or alteration in the old sound of his voice, as near as can be discerned. He was not used to drink hard; he is still alive, continues in good health, and has the use of his tongue as perfectly as ever he had in the former part of his life."

The preceding examples are special cases of remarkable dreams, but looked at in the abstract, any dream whatever is a remarkable one, the dream state being closely allied to idiocy. It is noteworthy that in dreams generally some preceding thought or act gives the bent to the dream; as when Henry Axford thought he fell into "a furnace of boiling wort," his preceding experience of falling from his horse was passing through his mind. Wonderful dreams may arise from contact with some substance which is thought, in the dream state, to be something else widely different. Thus, Dr. Gregory with a warm bottle to his feet thought he was walking about the hot crater of Mount Etna; Dr. Reid with a blister on his head imagined he was being scalped by a party of Red Indians; and M. Maury when tickled on the lips, thought pitch plasters were being torn off his face.

Excessive fatigue may give rise to strange dreams. A friend of the writer's, tired by overwork, dreamt during the night that a man entered his bed-room and approached his pillow. He awoke, but so thoroughly had the subjective vision got hold of him, that he still saw it in the waking state. It retreated towards the foot of the bed, and there it melted into nothing. Again, a gentleman who had had no sleep for forty-one hours was so overcome as to fall asleep and dream, while engaged in writing up his diary. He was writing when he fell asleep, and when he awoke he found he had entered up his dream.

GIANT CUTTLEFISHES.

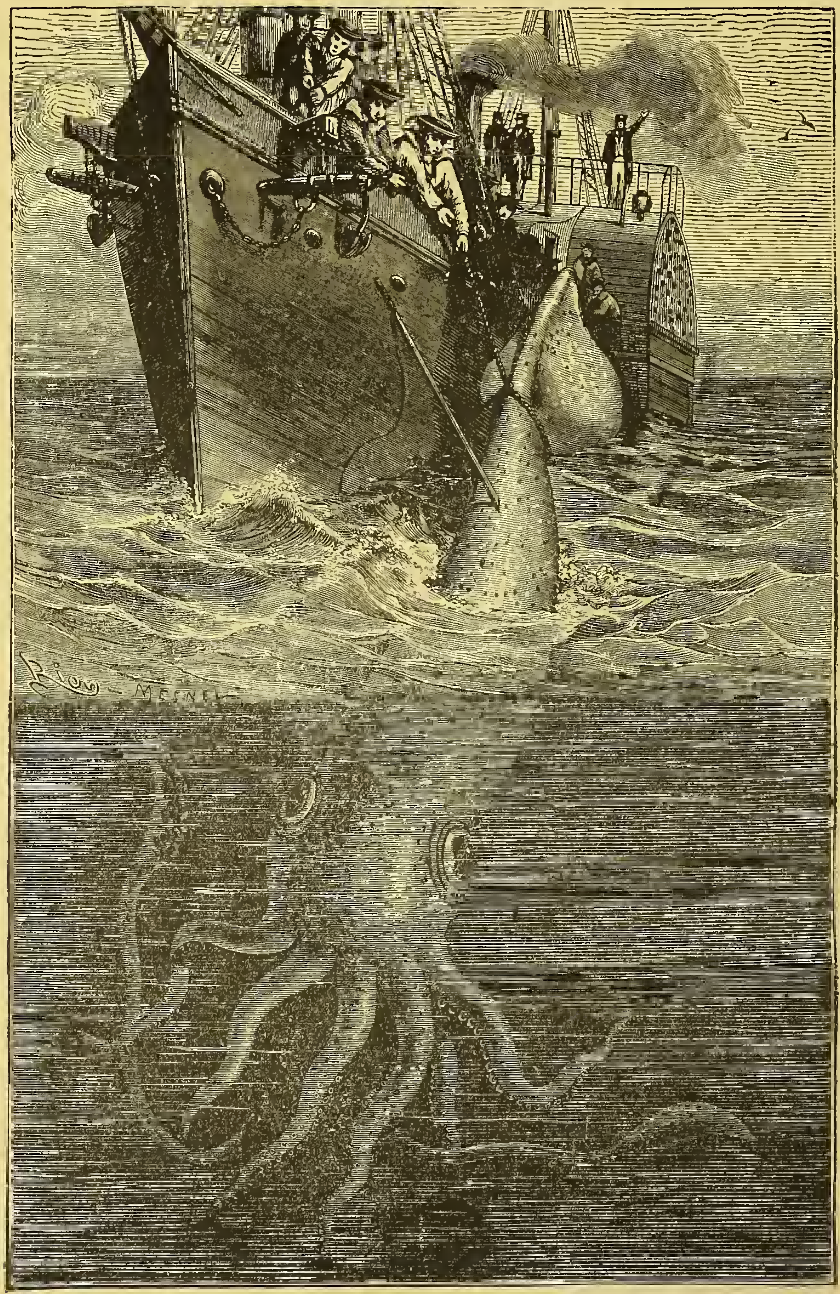
CUTTLEFISHES are animals belonging to the group known to naturalists as *Mollusca.* They are therefore near relations of the "Shellfish." Indeed, a cuttlefish may be regarded as having its body constructed on the same plan as that of a snail or whelk. At the same time it is of superior organisation to these latter animals, and exhibits a much higher structure of body, seen especially in the highly-developed nervous system. Any one who has seen an Octopus in an aquarium may recall to mind the chief features of the cuttlefish-group. When we look at an ordinary member of this group, we see a very distinct body, and as distinct a head. The head, indeed, forms one of the most prominent features of the cuttlefish group. It is far more prominent than that of the snail or whelk, and bears a pair of very large eyes ; the presence of these organs giving to the animals a singularly weird appearance. The top of the head bears a circle or crown of long arms. In the Octopus there are eight of these arms ; but in other cuttlefishes (such as the Squids) there are ten—two of these ten arms being longer than the remaining eight. The arms are provided with suckers ; and as each sucker can be instantaneously applied to any object, the grasp of the cuttlefish may be regarded as being of a very firm nature. The suckers are applied on the same principle wherewith a schoolboy's leather sucker is attached to a stone; in other words, the air below the sucker is exhausted, and the structure is kept applied by the pressure of the outer atmosphere.

Altogether, as regards their organisation, the cuttlefishes stand at the head of their class. The "shell" seen in the Molluscs is, however, developed in a rudimentary fashion in all living cuttlefishes except one — the Pearly Nautilus, or *Nautilus pompilius* of the zoologist. In the Octopus and its neighbours, a horny pen-like structure, or a limy plate (as in the *Sepia*), represents the shell of other mollusca. With their highly active habits, it would seem that the ordinary cuttlefishes of to-day have little or no need of a shell by way of protection or defence. They are amongst the wariest of animals. They capture their prey in a highly agile manner by aid of their tentacles, and they possess, when largely developed, a muscular power in the face of which even man may hesitate to attack them. They exist in all our seas and oceans. Those of the tropics present us with the greatest variety, but, as we shall presently see, the giant members of the group are by no means confined to tropical oceans.

From the earliest times, the cuttlefishes appear to have played a prominent part in the legendary lore of maritime countries. In the classical period, the existence of giant members of this group was often asserted. The ancient naturalists described many cases of the occurrence of these animals, although these accounts, until within a few years back, were regarded as mere exaggerations. Pliny, for instance, gives an account of a giant member of the cuttlefish group which was alleged to haunt the coast of Spain. Its body was stated to have weighed 700 pounds, and its arms to have measured 10 yards in length. The weight of the head was likewise set down at 700 pounds.

The most famous of the legendary cuttlefishes was the *Kraken.* According to naturalists of the middle ages, this was a gigantic monster which inhabited the northern seas, especially the coast of Norway, and resembling in size a small island rather than a beast. One Denis de Montfort, not so very long ago, seriously described a colossal "poulpe"—this latter name being equivalent to that of Octopus — which he actually figured in the act of destroying a three-masted vessel. The animal is represented as tearing down the masts and yards, and as making short work generally of vessel and crew. Indeed, De Montfort was so unscrupulous in his inventions, that he boldly asserted his intent to make this giant poulpe capable of swallowing a whole fleet of ships, if his first and milder instalment of its powers were accepted by the public. It may be interesting to quote at this stage the account given by Pontoppidon, Bishop of Bergen, of the Kraken itself. "Its back," says this author, describing from imagination aided by the exaggerated narratives of sailors, "which appears to be a mile and a half in circumference, looks at first like a number of small islands surrounded with something which floats like seaweeds ; here and there a larger rising is observed like sandy banks ; at last several bright points or horns, appear, which grow thicker the higher they rise, and sometimes they stand up as high and large as the masts of middling-sized vessels. It seems that these are the creature's arms (it is evident that the author has the idea of a cuttlefish before him), and it is said that if they were to lay hold of the largest man-of-war, they would pull it down to the bottom. After the monster has been a short time on the surface of the water, he begins slowly to sink again ; and then the danger is as great as before, because the motion of the sinking causes such a swell, and such an eddy and whirlpool, that he carries everything with him." Pontoppidon further enlarges on the idea that the existence of the Kraken gave rise to stories of the disappearance of islands ; the "islands" which were thus credited with having passed out of existence being merely the huge bodies of the Kraken and its allies.

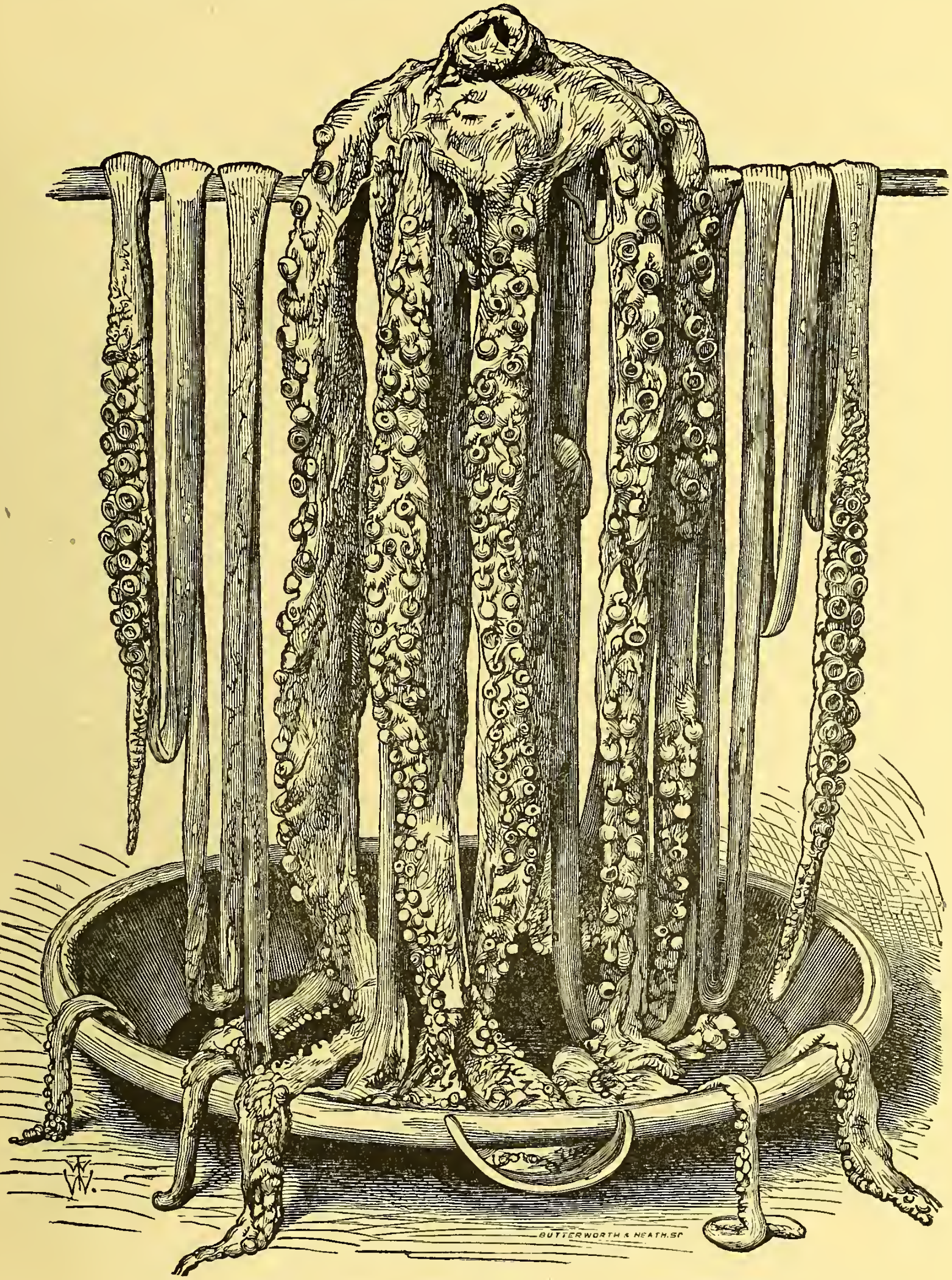
But the tales of the giant cuttlefishes had evidently penetrated to regions farther south than the area said to have been inhabited by the Kraken.



SQUID ENCOUNTERED BY THE "ALECTON."

De Montfort tells us in his natural history of the Mollusca, that one Dens, captain of a merchant-vessel, related particulars of an attack made upon his vessel off the coast of Angola by a huge poulpe. Its arms were thrown across the vessel, and it proceeded to demolish the masts, when the crew, attacking it with hatchets, succeeded in releasing their ship from its grasp. The arms were set down as being thirty-five feet long, and the suckers borne on the arms were said to have been as large as saucepan-lids.

Modern naturalists, it will readily be believed, refused to credit the tales of De Montfort and Pontoppidon. The Kraken, for them, had no



HEAD AND TENTACLES OF A GIANT CALAMARY FOUND OFF NEWFOUNDLAND.

existence. It was merely a myth, which doubtless, like most other legends, had sprung from a germ of truth and fact, but which, at the same time, had so overgrown the original incident as to render futile all attempts to trace the actual occurrence. It is highly instructive, however, as well as both curious and interesting, to note how the truth and reality of nature has of late years been presented to our view from beneath the overlying mass of legendary lore. For many years before the actual existence of giant cuttlefishes was ascertained, naturalists had received occasional fragments and detached pieces of evidence that their existence was a matter of fact. It is therefore extremely curious to note how this evidence at last became of a full and complete nature, so as to place the occurrence of these giants of the Molluscan race beyond a doubt.

Several of the early explorers placed on record that the remains of giant cuttlefishes were by no means uncommon in the seas and oceans at large. Péron, for example, tells us that he met with a cuttlefish eight feet in length in the Australian seas; such dimensions far exceeding the ordinary sizes of these animals. Near Nice, a cuttlefish of the Squid species was found, which weighed thirty pounds; and at Montpellier, the remains of a specimen six feet long have been preserved. Quoy and Gaimard, the celebrated explorers, detail the occurrence of a monster cuttlefish in the Atlantic Ocean. It was dead, and according to their calculations must have weighed about 200 pounds. Molina, describing the natural history of Chili, speaks of Sepias weighing 150 pounds. In Captain Cook's first voyage, a dead cuttlefish, found floating in the sea, is described as having measured six feet in length, inclusive of the arms. On the coast of Denmark a large Squid was cast ashore, and measured twenty-one feet in length of body alone, the tentacles being eighteen feet long. In 1854, on the coast of Jutland, another specimen was stranded. The fishermen cut up the body for bait, and it was so large that it furnished many wheelbarrow-loads. The beak or jaws of this specimen were said to have been nine inches long.

Again, in 1861, the French war-steamer *Alecton*, when sailing between Teneriffe and Madeira, fell in with a giant Squid. The body alone was estimated to be eighteen feet long, and the colour, as in the Squids, was described as being of a reddish-brick hue. The hinder part of the animal was secured, having been pulled off by the rope which was passed round the tail extremity. This portion, which was seen by the French Consul at Teneriffe, weighed about forty pounds, and a painting was made of the event, from which the accompanying illustration is copied. After the recital of these well-verified appearances of cuttlefishes, which vastly exceeded in size the ordinary members of the group, the ancient legends appear rather as slight exaggerations than as actual myths. It remained, however, for the observations of the last twenty years or so to show that the existence of actual giants of the cuttlefish race was an undoubted fact.

On the North American coast, and especially in the region of Newfoundland, several instances of giant cuttlefishes have from time to time been recorded. In October, 1873, two fishermen were pursuing their avocation in a small punt about nine miles from St. John's, in Conception Bay. Espying a floating mass in the water they rowed towards it, when one of the men struck the supposed inorganic object with his oar. At once the mass awoke into vitality and stretched out its arms towards the boat; in other words, the fisherman had inadvertently surprised a sleeping, or at least a quiet and floating cuttlefish. It was apparently of large size, and as two of its arms were shot over the boat, one of the men promptly cut them off with an axe. The animal next ejected a quantity of the inky fluid these beings possess by way of a defence for obscuring the water, and then swam away. The cuttlefishes, it may be mentioned, propel themselves very swiftly through the sea by means of jets of water expelled from a tube or "funnel" placed in the front of the body. The water thus expelled is that which has been used in breathing, and these animals thus progress by a kind of hydraulic engine, such as human ingenuity has applied in the propulsion of vessels. The men estimated the size of body in the specimen just described at sixty feet, and its breadth across the tail-fin at ten feet. These proportions, it is safe to say, were exaggerated, because the men had little or no opportunity of forming an exact judgment of the size of their antagonist. But the portions of the arms which were chopped off enabled an American naturalist to calculate the length and other dimensions of the animal. These are given as follows:—length 10 feet; length of the long arms or tentacles 32 feet; length of head 2 feet; total length about 44 feet.

In November, 1873, curiously enough, another Calamary or Squid of large size was met with off the Newfoundland coast. On this occasion, the animal was brought ashore in the fishermen's nets. The body was 7 feet in length, and the tail-fin 22 inches broad; the two large arms were each 24 feet long, and the eight shorter arms 6 feet in length. The total length was 32 feet; the eyes were 4 inches in diameter, and the number of suckers was estimated at 1,100. Between 1870 and 1875 various specimens of similar giants, attaining a length of from thirty to fifty-two feet, inclusive of arms, were found. It is probable that these giant cuttlefishes haunt the Newfoundland coast on account of the shoals of cod and other fish with which that region teems. Our own coasts, also, do not want for examples of giant cuttlefishes. A Captain Neill, of the ship *Robertson*, of Greenwich, in 1834 was voyaging between that port and Montrose. On the 22nd of June in that year, he fell in with a large sea-monster, which, from the description and sketch given of the occurrence, seems to have been a giant cuttlefish. On Sunday, the 5th of August, 1876, the master and mate of a Norwegian ship saw, off the Scottish coast, a huge animal, also believed to have been a largely-developed cuttlefish. The occurrence was testified to before a Dundee magistrate. Near the Shetland coasts, large cuttlefishes have been seen on more than one occasion. On the Irish coast, on the 26th of April, 1875, a huge cuttlefish was seen and chased. The account given of the occurrence is as follows:—"On the 26th of April, 1875, a very large Calamary (or Squid) was met with on the north-west of Biffin Island, Connemara. The crew of a curragh (or coracle) observed to seaward a large floating mass surrounded with gulls. They pulled out to it, believing it to be wreck, but to their astonishment found it was an enormous cuttlefish, lying perfectly still, as if basking on the surface of the water. Paddling up with caution, they lopped off one of its arms. The animal immediately set out to sea, rushing through the water at a tremendous pace. The men gave chase, and, after a hard pull in their frail canvas craft, came up with it, five miles out in the open Atlantic, and severed another of the arms and the head. These portions are now in the Dublin Museum. The shorter arms measure each eight feet in length, and fifteen inches round the base; the tentacular arms (or longer arms) are said to have been thirty feet long. The body sank."

Reviewing the details just recorded, it will be seen that all but the most exaggerated legends of the older naturalists and writers were founded on a solid substratum of truth and fact. The most curious part of the recital, perhaps, is the fact that it is only within very recent years that these huge animals have been met with in the flesh, and in their entirety. This fact alone may serve to impress the notion, that hidden in the sea-depths from the eye of adventurous man, there may exist creatures of larger size and stranger form than are dreamt of in our furthest philosophy.

EXTRAORDINARY FINGER-NAILS.

THE finger-nails of those who are employed as artisans differ remarkably from those of persons following other, and in a sense, less arduous pursuits. In the former case they are as a rule short, thick, and in many ways adapted for the rough usage to which at times they must be inevitably subjected; in the latter, they frequently acquire considerable length, and become thin and flexible, merely because the hands are seldom or never employed in those "wearing" tasks with which the workman in all parts of the world is constantly occupied. No doubt from the effect thus produced by manual labour upon the nails of the fingers arose the notion, entertained at least by the old novelists, that prettily-formed "rosy, filbert nails," were a mark of aristocracy; and indeed it is quite possible that such forms may be to some extent inherited in youth, but would hardly preserve their symmetry through manhood and age if subjected to the constant rough usage to which the finger-nails of a bricklayer, for instance, are daily liable. We, however, seldom see finger-nails which extend above two or three millimetres beyond their junction with the fleshy part of the finger, and are apt to regard with aversion rather than with admiration nails which are permitted to attain a much greater growth. With us, however, unless it be an upstart *parvenu*, no one thinks it an indignity to follow some manual occupation, and many a gentleman amuses himself and employs his spare hours in carpentry, sculpture, or turning with the lathe. Nevertheless, it may be fairly affirmed that the inhabitants of any civilised country, such as England, France, or Germany, might, with a very near approach to accuracy, be divided into two classes of writers and labourers by the form of their finger-nails alone, though it would be far from true to state that by this means could be decided the social position or the mental acquirements of each person.

When, however, we travel to the far east, we find the form of the finger-nails proclaiming unquestionably the claims of their owners to rank and fashion, and are astonished that any people should be willing to submit themselves to the inconvenience which such distinction necessitates. We are all more or less acquainted with the extraordinary manner in which the feet of Chinese ladies of the upper ranks are disfigured during infancy, so that in after life they are of little or no service as organs of progression, but become mere mummied records of what they might have been. So also we find both men and women belonging to the upper classes permitting the finger-nails to attain an enormous, and to our eyes a hideous development, under the same influence of the *mode*. Chinese belles and dandies are in consequence often to be seen with the nails projecting from an inch to an inch and a half beyond the finger-tips; and these unseemly appendages are pared and tended with the utmost care, and are regarded with pride and gratification by their happy possessors.

But it is in Siam, in Annam, and in Cochin China that this extraordinary custom is carried to its greatest development. The nobles of Annam, for instance, permit their nails to grow to such a length that the hands are absolutely useless for any practical purpose. The nails on the second, third, and fourth fingers attain a length of from four to nearly five inches. They are straight, with a slight inward curve, and present the appearance of immense claws or talons; which we could imagine might be of use to man in his most savage state, for scratching up the ground to find roots or seeds, but certainly do not appear adapted for either use or ornament under any of the ordinary incidents of life. The nail of the thumb is hardly so long as those of the other digits. It at first grows nearly straight, with also a tendency to curve inwards, but presently takes the form of an elongated spiral, and must almost entirely prevent the use of the thumb as an organ of prehension. On the first finger alone is the nail kept within reasonable bounds, and with this only must be performed all those innumerable trifling acts which taken together add so greatly to our comfort and well-being.

It sometimes happens that the nails are allowed to grow to a great length to indicate that the wearer leads a religious life, and has forsworn at once the labours and the frivolities of the world. The hand of a Chinese ascetic, leading such an indolent and wasteful existence, presents the most extraordinary spectacle. The nail of the first finger is indeed, as in the case of the Annamese already described, left sufficiently short to render the finger of some practical service. The other fingers are, however, disfigured by immense horny growths, which can scarcely be called nails, which reach the enormous length of from *sixteen to eighteen inches.* These hideous excrescences do not grow straight and claw-like, as do the Annamese nails referred to above, but in a curious irregular spiral curve, the nails of the second and third fingers interlacing in an extraordinary and particularly ugly fashion. The nail of the little finger, after projecting for some distance almost straight, with a slight upward tendency, makes a sudden bend, and reaches with a regular sickle-shaped curve across the nails of the two neighbouring fingers. The thumb is furnished with an almost flat nail, which assumes a spiral form from its immediate junction with the fleshy part of the organ.

HAND OF AN ANNAMESE NOBLE.

This extraordinary development of the finger-nails is supposed to be produced by hypertrophy of the horny tissues, induced doubtless by some special agency or mechanical irritation for the purpose of obtaining a plentiful secretion of the horny material. But that any state of society should exist in which to render the hands thus utterly useless and hideous was regarded as a virtue, cannot but strike persons unaccustomed to such vagaries of fashion as remarkable in the extreme.

So essential as a mark of nobility, however, are long nails regarded in what is known as the Transgangetic Peninsula, that Siamese actors and actresses, when playing the parts of "lords and ladies," usually appear with long silver horn-shaped ornaments attached to the ends of the fingers, not to represent the nails themselves of the aristocracy, but those long silver cases with which the *beaux* and *belles* either protect these valuable appendages when they are there, or make believe that they are there when in reality they are absent.

Though it is in Siam and the neighbouring states that the custom of wearing these prodigious appendages reaches its most ridiculous height, yet long finger-nails are more or less fashionable in many other parts of the world. Gentlemen in England and in France may often be found taking a pride in the exuberant development of these organs, while throughout the East it is more or less the fashion to permit one or more of the nails to attain what may be regarded as an abnormal growth. Thus ambassadors and visitors of distinction from Asiatic states to Europe, are often observed to permit the excessive growth of the nail of the little finger, and this is also a common occurrence with many of the people in India and other parts of Asia.

With whatever feelings of disgust the appear-

SIAMESE ACTOR, REPRESENTING A NOBLE, WITH NAIL-CASES.

ance of hands thus furnished may fill us, we should, however, remember that for the anatomist and physiologist not a little interest is attached to this excessive development of the finger-nails. For by this it is seen that certain growths of the nail hitherto regarded as abnormal and extraordinary, are in reality indications of the normal growth of the nails when carefully preserved from all retarding influences. Nevertheless it cannot be supposed that the nails upon our hands and feet were ever intended to attain such extraordinary length, and it is in fact only by becoming entirely dependent upon the service of others that these aristocrats of the half-civilised countries of the East are enabled to proclaim their miserable superiority to their fellow-men.

THE BIRD-HERMIT.

In an old book of travels in Spain, written by Mr. Thicknesse and published about the close of the last century, we have a very curious record of what he terms "the bird-hermit," of whose fame he heard when in Catalonia, and whom he visited. It is the duty of those who isolate themselves from the haunts and companionship of men, as hermits, to devote their every thought and hour to prayer and self-denial, to have with them in their lonely cells no cat, dog, bird, nor any living thing whereby their hearts might be weaned from God and their thoughts given to His creatures instead of to Him alone. Mr. Thicknesse says, therefore, of this bird-hermit:—

"He cannot be said to transgress the law, but he certainly evades it; for though his feathered courtiers do not 'live within the walls,' they are always attendant upon his court; nor can any princess upon earth boast of heads so elegantly plumed as may be seen at his court. . . . If his meals are scanty, his dessert is served up with song, and he is hushed to sleep by the nightingale."

His hermitage, which was situated in a deep lonely valley, consisted of a few small buildings standing in a garden at the foot and amongst the roots of a gigantic pine. It was called St. Catherine's, and was shut in by foliage. The days there were almost always mild and bright throughout the year, and it was the favourite resort of innumerable birds, with whom the hermit of St. Catherine was upon terms of the most extraordinary intimacy. They came to his call, clustered upon his person, nestled to rest in his beard, and fed from his hand and mouth, permitted him to caress them, and would allow his visitors to caress them also—but only when he was present. The hermit himself was a courteous, affable, and amiable man, who fed upon vegetables exclusively. Hearing the voice of man rarely and at long intervals, he found consolation in the songs of his birds, to which he gave food, shelter, and safe places for nesting.

"If there is a happy man on earth," wrote Mr. Thicknesse, "there he dwells. His features, his manners, all his looks and actions announce it, and yet he had not a single maravedi in his pocket. Money is as useless to him as to one of his blackbirds. . . . Here the nightingale, the linnet, and an infinite variety of little songsters, greater strangers to my eyes than fearful of my hands, dwell in perfect security, and live on the most friendly intimacy with their holy protector. . . . I was sorry my host did not understand English, nor I Spanish enough, to give him the sense of the lines written in poor Shenstone's alcove:—

"'Oh, you that bathe in courtly bliss,
Or toil in fortune's giddy sphere,
Do not too rashly judge amiss
Of him that bides contented here.'"

LIFE SAVED BY A HEN.

On the 19th September, 1751, when a grand entertainment was given in the Hall of the Apothecaries' Company to celebrate the election of a new master and wardens, a picture of one of the society's founders was presented to them, and the following story was told in connection with it. The original of the portrait, who lived in the reign of James I., while in France was committed to prison as a Protestant, and cruelly ill-used. At last he was left in his dungeon entirely without food. After some days he was astonished to find a hen in his cell, the bird having contrived to force herself through the bars of a small low aperture near the ground. Every night the bird returned, and every morning the starving prisoner found an egg laid for his breakfast. These eggs preserved his life, and soon after he contrived to escape and cross the sea to England.

AT SEA IN A COFFIN.

An old magazine, published in 1821, records the extraordinary escape of a Dutch sailor, then alive in Holland in the town of Horn. For participating in a mutiny, which resulted in the death of one of the officers, he was sentenced to be hanged. The captain being, however, reluctant to execute him, determined to send him to the uninhabited island of St. Helen, off which the vessel was lying becalmed and unable to move. The boat which carried him from the ship contained also the body of the slain officer, in a hastily and rudely constructed coffin. This was buried in the island, and a post set up to mark the grave, after which the unfortunate sailor's shipmates wished him a melancholy good-bye. The horror of his desertion and solitary state so preyed upon the Dutchman's mind that he determined upon running any risk rather than remain on the island. He therefore dug up the dead body, removed it from the coffin, and converting the coffin-lid into a kind of rudder, carried the other part down to the shore, and, getting it afloat, sprang into it. The vessel was a league and a half away, but he contrived at length to paddle towards it, and was presently spied by the look-out. The crew and captain were not a little startled to see a coffin afloat, and were still more surprised when they discovered that the condemned man had been desperate enough to trust himself upon the sea, calm as it was, in a box made with three thin boards slightly nailed together, in order to reach those who had already condemned him to swing from the yard-arm. He was taken on board, and, after considerable discussion, was allowed to live until he reached Holland, by which time it had been determined to pardon and set him free.

ICE AND WATER.

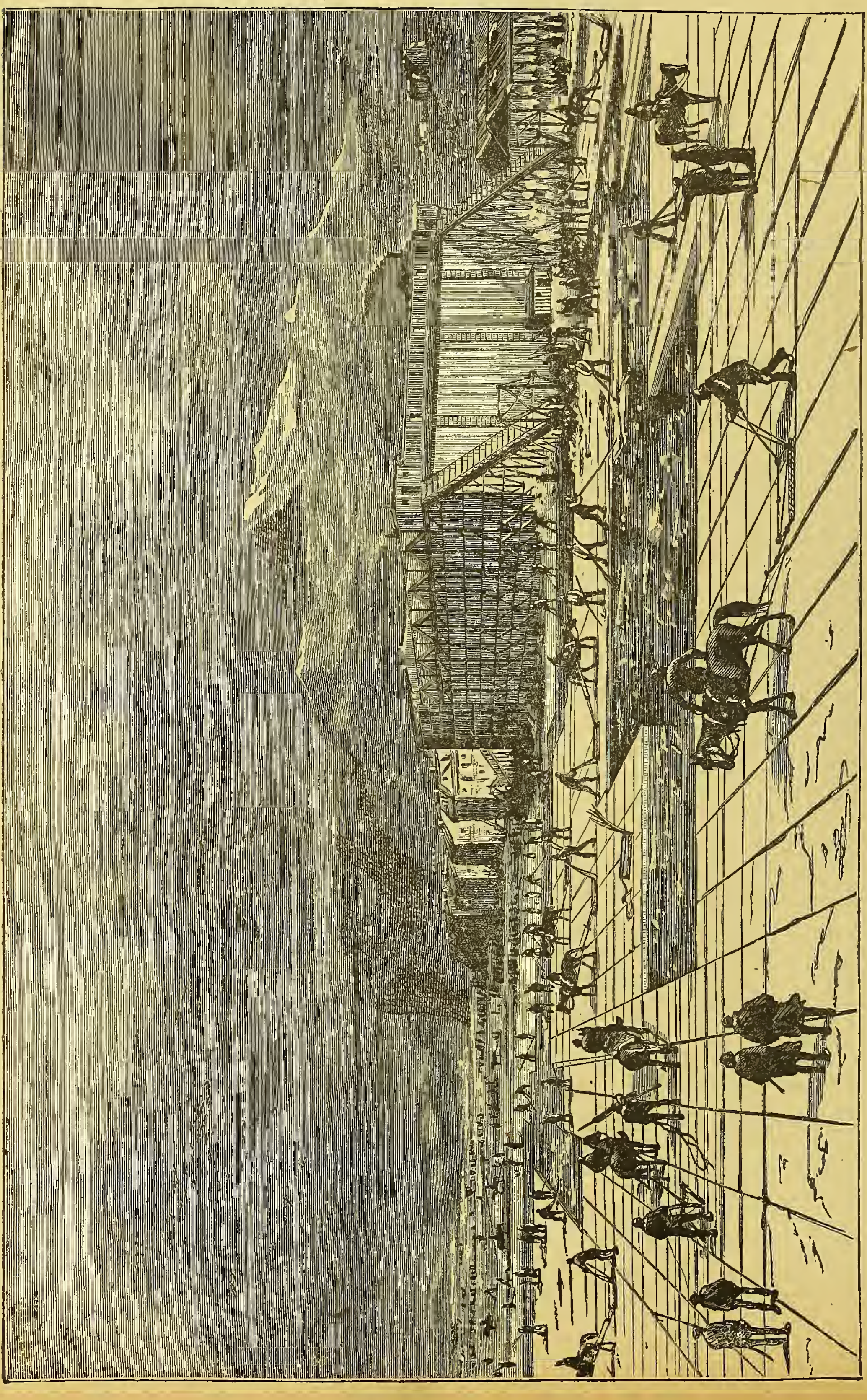
We are apt to think of it as "natural" that the air we breathe should exist in the form of a gas, water in the form of a fluid, and other substances around us in a solid state; and we say that the air *is* a gas, water a fluid, and iron or copper a solid, accordingly. But the truth is that Nature has no such essential distinctions, and that all these states of matter are simply results of circumstances. They partly depend on temperature, and partly also on the surrounding pressure. It may be said, without an exception, that under certain conditions of high pressure and low temperature all the known gases have been liquefied, and many of them solidified; while, on the other hand, we know now that sufficient heat will not only melt the most refractory metals, but convert them into gas. Mercury is as real a metal as any other, though it becomes solid very far below the freezing-point of water; and so when we say that water "freezes" at 32° of English thermometers, we simply mean that under the ordinary pressure of the atmosphere this is the temperature at which the fluid becomes solid, or the solid fluid, just as, at a very different temperature, a paraffin candle does the same. In the same way, at the higher temperature of 212° in the open air the water assumes the shape and obeys all the laws of a true gas, being then called steam. The steam is as really a gas as ammonia. We shall see in a future article how entirely these melting and boiling points depend on pressure; so that not only does water boil when only comfortably warm at the top of Mont Blanc, but under certain conditions ice may be surrounded by a temperature higher than that of boiling water without melting; and there is much reason to think that in an absolute vacuum, could we obtain and keep one, the fluid state of any substance would be impossible at all.

Ice, or water, in its various forms, is one of the most remarkable substances known. The exception it offers to the general law of expansion by heat and contraction by cold, expanding as it does from 39° down to the freezing-point, is well known; also the importance of this to us in preventing the conversion of ponds, rivers, and oceans into vast masses of ice during a frost.* Almost more remarkable, however, is the enormous amount of its "specific heat," or heat required to raise a given weight by a given temperature, say a degree, while, conversely, heated water gives out again enormous heat in cooling one degree. No solid or fluid substance, and no other substance whatever except hydrogen gas, one of its components, and the most inflammable substance known, *approaches* water in this respect, which makes it so valuable for warming and many other purposes. Related to this property is its extraordinary amount of "heat of fusion," or vaporisation, commonly called "latent heat." An enormous amount of heat must be applied to melt a quantity of ice, or to boil away into steam a quantity of water, as we all know. All this time, the ice or the water is not raised in temperature one fraction, and hence the heat absorbed is called "latent." Conversely, however, when the water is frozen or the steam liquefied, all this quantity of heat is given out again. Thus it is that in a thaw, by the very melting of the ice or snow, heat is absorbed, the atmosphere cooled, and the thaw kept from being so rapid as to cause inundations; while, on the other hand, in freezing the heat is given out, and the temperature moderated. The same applies to the evaporation of water. In this way, by these properties, in which the substance known as Ice—Water—Steam is so remarkable, it acts as the great *steadier* of temperature all over the globe. Finally, the difference between the freezing and boiling points of water—32° and 212° Fahr.—is extraordinarily small; so that man is able to obtain and use this kind of matter in any form most convenient for his purposes, with the greatest ease.

Without the shadow of doubt all these remarkable properties, extraordinary as they appear, are the result of general physical laws. But they are none the less extraordinary; none the less as far as possible from being accidental or undesigned. When we find physical laws bestowing upon the most plentiful of substances properties so remarkably subservient to both animal and human life, the most natural reflection must be concerning the wisdom of laws which accomplish such far-reaching results.

While all know that there are still large regions of the earth in which ice is the "natural" condition, and water has to be liquefied from it by artificial heat, few people realise what immense masses of this solid water are congregated round the poles. Think of a massive ice-sheet hundreds of feet in thickness, from which are broken off as mere fragments those giant icebergs which we must describe in a future article. Remember that these gigantic glaciers still linger even in the region of Italy and Switzerland, and that there was a time not so very long since (as geologic ages go) when this grim mass of ice covered nearly all of what we now call Europe or the temperate zone. Now it is different; but ice is so necessary to us—in hot climates it is really more of a necessity than a luxury—that from very early ages the greatest pains have been taken to preserve it for the use of man. The Romans fetched pressed snow from Sicily and the Apennines; and the Hindoos from time immemorial have made ice by

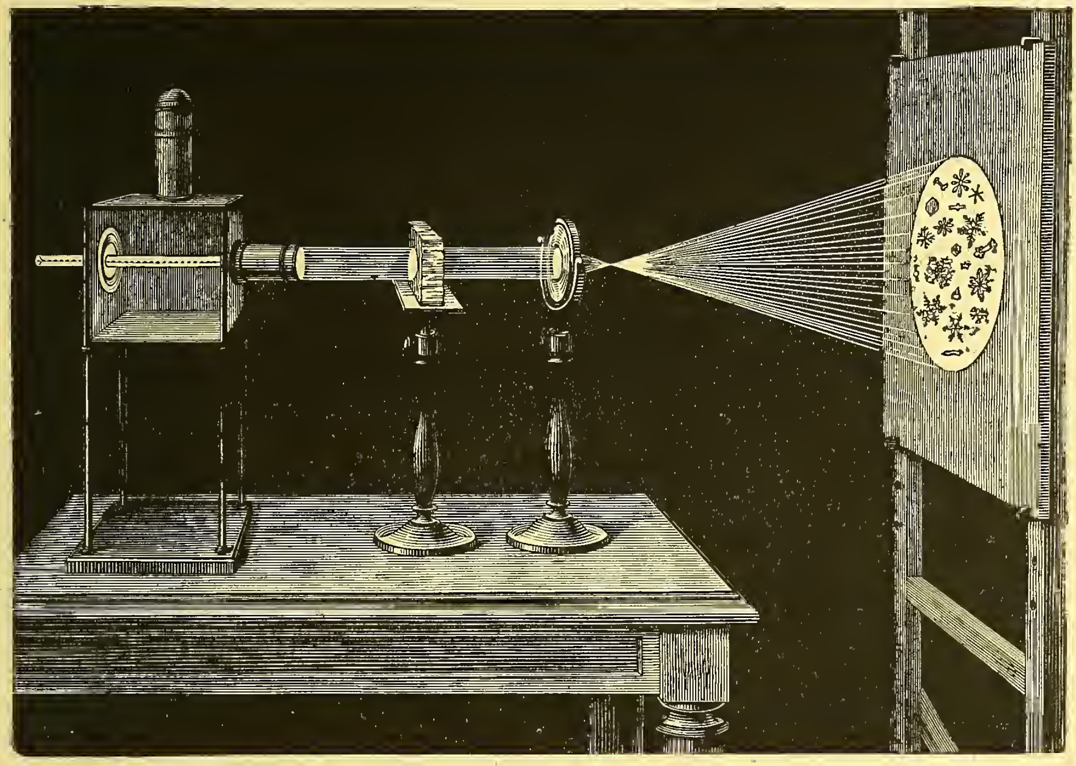
* The expansion during the fluid state, from 39° to 32°, is the remarkable fact. Expansion in freezing is shared by many metals and other substances.



THE ICE HARVEST ON THE RIVER HUDSON.

evaporation in the dry night air, carrying to perfection the process by which we cool water in porous jars. In open and dry plains they dig pits twenty or thirty feet square and a couple deep, in which they set very wide, flat, porous earthenware pans about an inch deep, upon light bamboo frames or stiff open straw. They thus promote rapid evaporation both from the surface of the water and the bottom surface of the pans, and the result is a thin coating of ice which is carefully stored away before sunrise. In recent years ice is made on the same principle of rapid evaporation by complicated and costly machines, which hasten the evaporation of very volatile liquids by a vacuum kept up by mechanical means.

The greatest supply of ice for almost the whole world is now Northern America. There has grown up a vast ice-industry, which exports yearly thousands and thousands of tons to the Southern States, to England, France, and Italy, the Cape, Australia, and India. The fresh-water lakes of Canada supply a great deal of this, and Wenham Lake is by no means the only one; but of late years a large industry of the same kind has grown up on the River Hudson, at about a hundred miles from New York, which is represented at full swing in the accompanying plate. Along each shore are immense storehouses, each of which will hold, say, 50,000 tons, and which are built of wood, double, with an air-space between the two skins of the wall, to prevent conduction of heat. The harvest commences when the ice on the river is about nine inches thick; then a smoothish surface being chosen, is marked out, and ice-ploughs cut grooves nearly through (only leaving enough to bear the weight of men and machines), so as to divide the area into oblong rectangles of nearly a square yard each. A portion containing many squares is then detached by a pickaxe, and drawn near an ice-house, where each block is separated by a strong iron fork, and placed on the foot of an "elevator," or endless band travelling up an incline. At the top of the slope the blocks are seized and stowed, leaving a space of a few inches between them to allow circulation of air, keep from freezing together, and allow water to drain away. The Hudson ice goes mainly from New York; the Canadian from more northern ports. At Boston alone the industry employs 4,000 men, and in Canada a great many more. Such is the demand for this solid water in all quarters of the globe; and the magnitude of the traffic is further shown by the fact that in London ice can



TYNDALL'S EXPERIMENT, SHOWING THE CRYSTALLISATION IN A SLAB OF ICE.

generally be purchased in the hottest season at about two-pence per pound.

But we have by no means fully described ice when we have said that it is water cooled or "frozen" to the solid state. Let us compare it with something else that, at first sight, may appear very similar—glass. We often hear it said that some piece or other of ice is "as clear as glass." Both are brilliantly clear; both are brittle; both can be melted by heat, and converted into gas by more heat. How much alike they seem; and yet there is a fundamental difference. In glass we can discern no sign whatever of orderly building-up, or symmetrical parts—in other words, what scientific men call "structure." It not only breaks "anyhow," but in cooling also it shows no tendency to take any particular form; and in a fluid state it is very slow to diffuse itself among other fluid substances. It is what chemists and physicists call a *colloid*, a word which describes this special kind of matter. And when we mix other substances with it, solidification does not separate them, nor do they practically alter much the temperature at which it becomes solid, or "freezes." In all these points water is very different. It diffuses readily into other fluids (not colloids). If other things—such as salt—are mixed with it, the salt makes it much more difficult to freeze; and when it does freeze at last, there is a strong tendency to separate the salt or throw it out, so that the ice on the sea in the Polar regions is very nearly fresh. But, still more remarkable, the water cools in a particular form, always. If it freezes from thick clouds (which are quite different from steam in being small particles of real *water* suspended in air, not gas), it becomes "snow," and this snow is all made up of those beautiful forms with which Captain Scoresby's drawings have made us so familiar. They are all *six-sided*, six-pointed stars, or six-sided figures. They are many shapes, of varied and marvellous beauty, but all agree in this—that they are put together at the one definite angle of 60°, or one-sixth of a circle.

ICE-FERNS ON A PANE OF GLASS.

Now this is not only true of snow, but of ice also. In other words, ice is a *crystal*; it is not only water cooled, but water *crystallised*, and its crystallisation proceeds on the very same plan as the snow-crystals. Looking at the beautiful crystal ferns which in winter often form on our window-panes, a square of which is drawn on this page, we may not think so. In truth the crystallisation is in such a case often dragged out of form, as it were, by the adhesion of the glass surface: it is not the fact, as some of the text-books say, that on such a perpendicular plate of glass the angle of 60°, or its double of 120°, is always exactly preserved. But as a rule it is, even there: if the angle where the needles or little branches of crystal *join* their stems are measured, the peculiar angle characteristic of ice can, as a rule, be traced. On the surface of water itself, where the crystallisation is unfettered, the angle of the rays is invariable, and the very same as that of the snow-crystals, which are simply ice-crystals on a small scale. From this we learn still another thing—viz., that the *axis* of the crystallisation, or direction round which the stars or crystals are symmetrically built, is in ice perpendicular to the plane of freezing, or surface of the water. A wide sheet of ice may appear to be all clear and devoid of structure; but, on the contrary, all its molecules are put together on a mathematical plan, with most rigorous exactness.

By a beautiful experiment, Professor Tyndall showed this to be the case in a slab or block of solid, clear ice. Applying heat to such a slab, it is found that the particles are *unlocked* from the polar forces which bind them together, in precisely the same order which bound them together, as we should expect. This beautiful experiment is shown on p. 17. A beam of sunlight reflected from the mirror of a heliostat * is brought full upon a slab of clear ice, either natural, or so cut from a solid block that the parallel surfaces are parallel to the surface of the water on which it froze. The illuminated ice is focussed by a large lens, so that a brilliant enlarged image of anything that occurs in it is thrown upon a screen. As the heat of the sunbeam begins to act, the ice slowly melts at a number of points; but round each point it becomes fluid in the form of a *six-rayed star*, or six-leaved flower. The formation of the ice-crystal is reversed, and the structure of the ice stands revealed. In the blocks of Wenham-lake ice before any fishmonger's door, we may see patches of a cloudy white here and there, especially in warm weather. Examination with a microscope shows that such a milky patch is entirely due to thousands of these six-rayed stars or flowers, though they are so small as to be almost invisible to the naked eye.

We thus learn finally, that the wonderful structure of ice extends down to the most minute portions: the smallest bit is accurately built up upon one exact plan. We are therefore forced to imagine each separate smallest bit, or molecule, as being linked on to its neighbours by uniform polar forces, or laws; and equally forced to conclude that every molecule itself must be uniform, and also built up on the same plan. Can we see into this at all? We do know that every molecule, or very smallest portion of water or ice that *is* ice or water, is composed of *three atoms*—one of oxygen and two of hydrogen. It is easy enough to conceive of these three atoms being combined together as an equilateral triangle; and if we cut a lot of such triangles out of paper and put them together, we shall soon arrive at a six-rayed star. It seems natural to think the arrangement may be something of this kind. Extended investigations do not bear out this view, for though a certain relationship is found to exist between similarity in chemical composition and similarity in crystalline form, we do not find that every substance composed of three atoms to each molecule crystallises in this form. The hypothesis fails us in this precise form, as a general rule. But it may still serve to show us the *way* in which men of science begin to think about these problems; how definite to them is the idea of molecules and their structure; and the nature of some of the reasons why they are very sure that there must be and are definite laws by which the ultimate atoms of bodies are arranged together.

* The electric or lime-light will also answer the purpose.

THE SUEZ CANAL.

It would be difficult to exaggerate the advantages which the commerce of the world has derived from the construction of the Suez Canal. To have reduced the distance between India and Western Europe from 11,379 to 7,628 miles, thereby effecting a saving of thirty-six days in the voyage, is undoubtedly a great achievement, and one which must be allowed a place among the Wonders of the World.

M. de Lesseps declares that every intelligent child, on first seeing a map of Egypt, must have asked his teacher why the road to India was not across the Isthmus of Suez. This question had certainly engaged the attention of intelligent men long before Lesseps took it up and gave it such a practical solution. A canal across the isthmus was actually constructed 600 years before the Christian era, and served as a water-way for small vessels until about 1,000 years ago, when it was allowed to fall into disuse. Napoleon I. revived the idea, and instructed one of the great engineers of his day to investigate the matter; but, though a report favourable to the restoration of the ancient canal was presented to him by M. Lepère, the work itself was never touched.

To Great Britain the problem was necessarily one of vital importance. Her close connection with India, and the rapid increase of trade between the two countries, gave the people of this country a special interest in any scheme which promised to render intercommunication more rapid. Hence the scheme known as the "Overland Route" was readily approved by the Government and the commercial classes of this country. At best, however, the "Overland Route" was but a make-shift; it simply shortened the journey for Indo-European travellers, and accelerated the mails—that was all. But something more than this was wanted. A road to India across the isthmus, to be of greatest service to Europe, and to this country particularly, must be such as would not necessitate the disembarking and re-embarking of passengers and mails, and such as would permit merchandise also to be carried without the trouble and expense of transhipment. A maritime canal, wide and deep enough for ocean-going vessels, was the only plan which would meet all the necessities of the case. Was a maritime canal practicable; and would such a canal, if constructed, be financially profitable? These were the questions which M. de Lesseps debated with himself and with the world many years. An absolute affirmative was not to be hastily given by the great engineer for himself—he had to patiently win it, by persuasion from his friends and by the logic of facts from his foes. The story of the enterprise is one of true heroism, and worthy every way of being told in unwearying

detail, but we must content ourselves with a simple outline.

Two points of great importance were very quickly decided by M. Lesseps: first, that it was undesirable to follow up Napoleon's idea of restoring the disused canal; second, that the shortest and most direct practicable line between the Red Sea and the Mediterranean must be drawn. The route being fixed upon, questions of considerable interest and no little difficulty confronted him. Was the sea-level at the two extremities of the proposed canal about the same? or was there, as had generally been supposed, a difference so great that the canal would be literally flooded as soon as it was opened? Would the process of "silting up" choke the canal? Would it be possible to construct a port and keep the entrance clear on the Mediterranean side of the canal? When those questions were disposed of, there were others ready to present themselves, but these were the most difficult; except, perhaps, that of finding the tens of thousands of labourers which the work would require, and of feeding them in such "a desert place" when they were found.

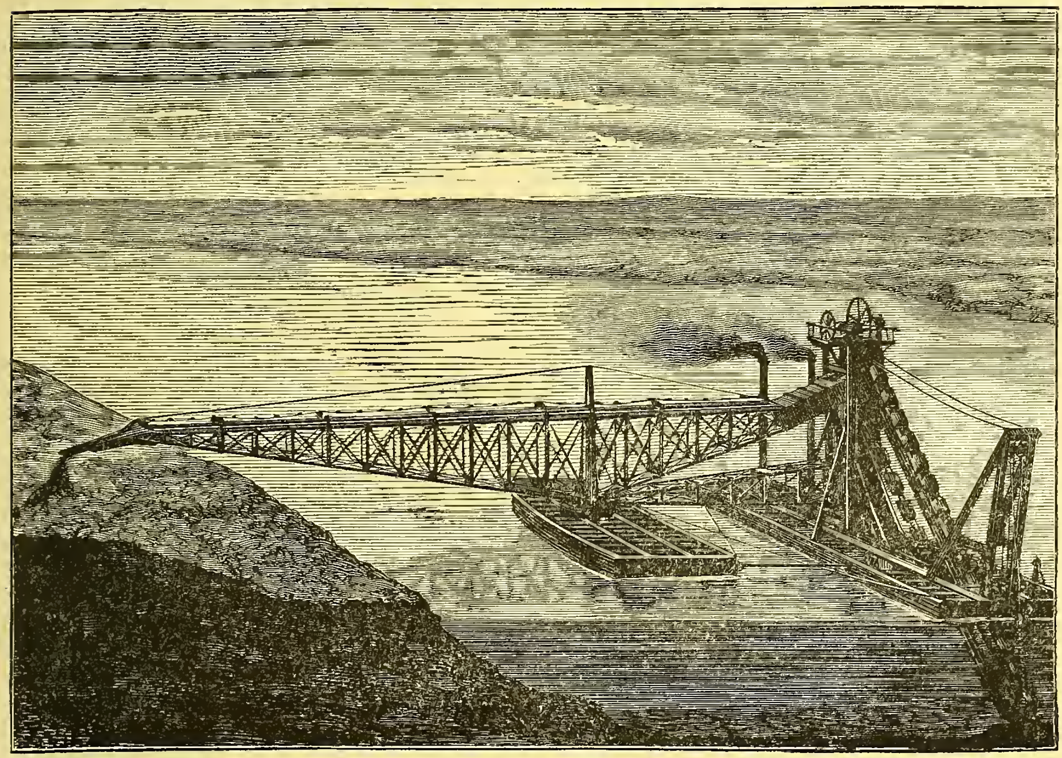
For the solving of some of these problems, M. Lesseps betook himself to the wilderness, and dwelt there four years, making observations and borings all over the course of the future canal. First and foremost, he perfectly demonstrated the fact that the level of the two seas was the same, and that there could be no danger of an inundation. A sojourn of a whole year on the shores of Lake Menzaleh satisfied him that a secure harbour could there be constructed. Patient watching and repeated scientific experiments proved that the sand of the desert did not accumulate as was commonly believed; and borings made at nineteen separate points between the Red Sea and the Mediterranean showed that the soil of the isthmus is firm and fixed; not liable, therefore, to become slimy, as the opponents of the undertaking had predicted. In short, M. de Lesseps, in the course of this preliminary investigation, reached two conclusions, which were afterwards confirmed by our own eminent countryman, Sir John Hawkshaw, C.E.—viz., 1, that no unusual engineering difficulties would be met with in the construction of the canal; and 2, that when made, no obstacles of an insurmountable character would prevent its being kept free for navigation.

Mohammed Said, the then reigning Viceroy of Egypt, watched the movement with sympathetic interest, and readily granted a concession to M. de Lesseps for the construction of the canal. No time was lost in bringing the scheme before the world. The French people received it with the utmost enthusiasm, and readily responded to the appeal for the necessary capital. In this country the project excited no small degree of hostility. Lord

Palmerston denounced it as "one of those bubble schemes which are often set on foot to induce English capitalists to embark their money upon enterprises which in the end will only leave them poorer, whoever else they may make richer." And the great engineer, Mr. Robert Stephenson, while not denying its practicability, cast doubts upon the commercial prospects of the project. To secure the support of English capitalists, M. de Lesseps visited this country, and held interviews with the authorities of many of the principal towns, explaining the leading features of his scheme, and pointing out the advantages which British commerce was certain to derive from its accomplishment.

The plans of the great engineer were, however, at length completed, and on the 25th of August, 1859, the making of the Suez Canal was begun. Engineers and skilled artisans were of course engaged from France and England; but the Khedive undertook to supply an army of fellaheen 30,000 strong, for the heavier and more laborious parts of the work.

The course of the canal is shown in the accompanying map. The whole length of the water-way is 88 geographical miles. Cuttings had to be made through 66 miles of the course; 14 miles of the bed were made by dredging through the lakes, leaving but 8 miles requiring no works of any kind, the natural depth being equal to that of the canal as projected. The canal was intended to have a navigable depth of 26 feet for a width of 72 feet *at the bottom*, the width at the top to vary according to the character of the cuttings. From Port Said the canal crosses about 20 miles of Menzaleh Lake, where it is 112 yards wide at the surface; 22 miles further it reaches Timsah Lake by means of a cutting through the ground to a depth varying from 30 to 80 feet; Timsah Lake itself is 3 miles long, and at this point the flourishing town of Ismailia has taken the place of what was a small Arab village. From Timsah Lake a fresh-water canal was made and fed from the Nile, to supply the population engaged on the line of the maritime canal. The work from Timsah Lake to the edge of the Bitter Lakes was very heavy. Deep cuttings, varying from 30 to 62 feet, were necessary; and, as the quantity of sand to be dug out was enormous, a large number of gigantic dredging-machines and elevators had to be employed. The deepest cutting of all was at El Gisr, where the canal is 173 yards wide at the summit-level, 112 yards wide at the



DREDGING MACHINERY USED IN THE SUEZ CANAL.

water-level, and 85 feet in depth. Embanking rather than excavating was the kind of work required in passing through the Bitter Lakes, the bottom of that region being very little above the intended level of the great canal. From the Bitter Lakes to Suez, a length of about 13 miles, the work again became severe, ground to the depth of from 30 to 56 feet having to be dug out and carried away.

Port Said owes its existence to the Suez Canal, but the canal itself could not be made until the Port of Said was built. That was M. de Lesseps' first task. He could collect no materials and build no workshops until he had dug a channel for the Mediterranean through the bare sand, and had constructed docks in which large ships could enter with their cargoes of stores. It was further necessary to build a vast breakwater, for the twofold object of keeping the mud out of the canal, and enabling vessels to approach the mouth of the canal with safety even in rough weather. This breakwater is now one of the most striking features of Port Said; the western pier runs out to a distance of more than a mile, and is separated by 1,500 yards from the eastern pier, which forms an arc of about 1,100 yards in extent. Stone, which had to be brought from a great distance, was at first used; but afterwards blocks of artificial stone, weighing 20 tons each, were made on the spot, by mixing sand and cement together in wooden boxes or moulds, then taking away the moulds and leaving the blocks to harden in the open air.

The sudden withdrawal of the native labourers by order of the Khedive threatened to bring the whole scheme to an inglorious conclusion; but M. de Lesseps and the contractors, MM. Birel and Lavalley, were equal to the emergency. They hired as many fellahs as they could, and superseded manual labour to a large extent by employing dredging-machines and elevators of colossal dimensions. These dredges, which were similar to those commonly used in cleansing rivers and canals in this country, were specially constructed for the purpose, and varied in size from 15 to 75 horse-power, the larger machines costing, it is said, £20,000 each. The elevator was a contrivance for lifting the box of sand from the dredger and carrying it on to the embankment. One end of the elevator hung over the punt or barge in which the boxes of dredgings were landed; each box was drawn up by a steel rope and carried on a small truck to the other end of the elevator, which extended several yards over the embankment. On reaching that point the end-door of the box opened, the contents emptied themselves over the ground beneath, and the empty box then ran down the return line of wire-rope back to the punt. A far more effective machine, however, was the long *couloir*, a sketch of which is given. This apparatus consisted in reality of a long mechanical duct, with a slightly inclined channel 5 feet wide and 2 feet deep, one end connected with the dredger and the other running out over the embankment. It was supported in the middle by an iron framework on the deck of a barge. A steam-pump kept a stream of water flowing through this channel; so that when the dredged-up matter fell into the upper end of the *couloir*, it easily ran through the duct and was cast ashore on the bank, thus saving all the labour of filling the dredgings into boxes and removing them to the bank by means of an elevator. The action of the *couloir* was sometimes aided by a *balayeur*—*i.e.*, an endless chain passing through the channel, and bearing with it a number of iron scrapers for removing accumulations of slime and mud. Some idea of the enormous size of these machines may be gained when we say that the largest of them were 75 yards long; and if placed on end, one of them would have towered nearly 8 yards above the Monument at London Bridge. The quantity of material removed by these gigantic excavators was 2,763,000 cubic yards a month—sufficient, as M. de Lesseps has calculated, to cover the Place Vendome five times the height of the surrounding buildings; or if laid out between the Arc de Triomphe and the Place de la Concord, to cover a mile and a quarter of the avenue to the height of the trees on either side! Such machines are still used on the canal to keep the channel clear.

The total cost of constructing the canal from first to last was, according to a report published in 1880, £17,518,729. The last barrier was pierced August 15, 1869, almost exactly ten years from the date of commencing the work; and the canal was opened for traffic November 17, 1869.

M. de Lesseps was sanguine enough to estimate that the tonnage of ships passing through the canal would be three millions in the first year, and would probably be twice as much during the second year. The following table, compiled from official sources, shows the actual growth of the traffic through the canal:—

	No. of Vessels.	Tonnage.
1870	491	436,618
1871	761	761,875
1872	1,082	1,439,166
1873	1,171	2,085,270
1874	1,264	2,423,672
1875	1,496	2,940,708
1876	1,461	2,095,870
1877	1,651	2,251,556
1878	1,593	3,291,535
1879	1,477	3,236,942
1880	2,020	4,344,400
1881	2,727	5,794,400

The company's charges for all ships passing through the canal are 10 francs per ton on the register tonnage, 10 francs per passenger, and 20 francs per decimètre for vessels over 20 feet draught as a pilotage charge. The total receipts of the company from all sources in 1881 were £2,200,000.

ELECTRIC MACHINES.

If, three hundred years ago, we had been required to write an account of electricity, we could have done so in very few lines. The science of electricity, as known up to the year 1600, was comprised in the fact that amber and jet possessed the curious property, when rubbed, of attracting any light bodies—such as feathers, bits of straw or paper—to which they were approached.

About the year mentioned a Dr. Gilbert found that many other substances possessed the same attractive property when excited by rubbing, and to these bodies he gave the name of Electrics. To substances which apparently did not share that power he gave the name of Non-electrics, and this rough division was adopted by all the experimenters of that day. Later on, it was found that this classification was inaccurate; for if such so-called non-electrics as the metals were isolated, or insulated by a handle of glass or porcelain, which prevented the electricity being carried through the hand which held them to the earth, such metals would show, on being subjected to friction, the same phenomena as the "Electrics."

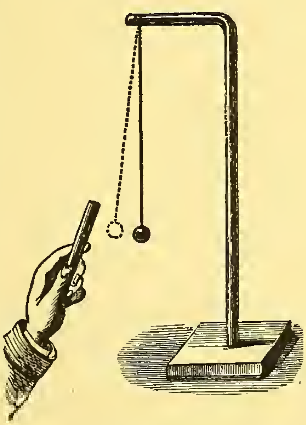


Fig. 1.

A stick of sealing-wax is perhaps the best material for these first experiments in electricity; and although it is easy enough, by rubbing it on the sleeve of one's coat, to prove its power, when thus electrified, of attracting any light particles placed beneath it, a far better contrivance, called an Electroscope, can be arranged with very little trouble. (See Fig. 1.)

It consists of a bent glass rod cemented into a wooden foot. To the projecting arm of this glass support is hung, by a fine thread, a little ball of elder pith, which, from its extreme lightness, is easily moved directly a rubbed rod of glass or sealing-wax is brought near it. We can with this simple little instrument try many experiments of an interesting character, which will help us in understanding something of that science which had its beginning six hundred years before the Christian era, and which has grown to such wondrous proportions in this nineteenth century.

We find, then, that this pith ball is attracted directly the rubbed sealing-wax is brought near it; but we also find that if the two things are allowed to touch, this attraction is at once changed to repulsion. Another thing which we can learn is that the rubbed body will be attracted to any substance which has not been thus electrified. By making a little cradle of wire in which to hang the rubbed sealing-wax in the place of the pith ball, we shall find that it will turn towards the hand directly the hand is lifted near it; but if we approach towards it another rubbed rod of sealing-wax, the suspended one will be immediately repelled. Another way of showing attraction and repulsion is to hang two pith balls to the glass support, and touch them with a rubbed glass rod: they immediately fly apart, and will separate still more as the rod is brought between them. But on approaching towards them a rubbed rod of sealing-wax, they will be attracted by it.

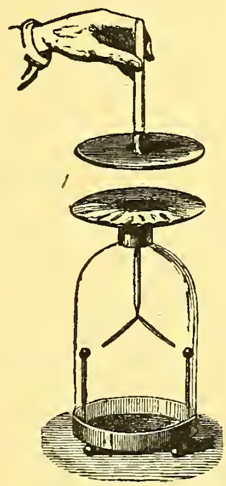


Fig. 2.

Hence it was surmised by early experimenters that there were two kinds of electricity — the one being excited in glass by being rubbed with silk, and the other being aroused in resinous substances, such as sealing-wax, by friction against flannel or wool. The first was called vitreous electricity, and the second resinous electricity. These names have now been given up in favour of the epithets positive and negative, the electricity appearing on rubbed glass being positive, and that on rubbed wax being negative; and the algebraic signs + and − are generally used to denote the electrical condition of any substance under consideration. A few experiments with the pith ball will soon teach us that two positively electrified bodies—or two negatively electrified bodies—will repel one another; but that a positively electrified body will attract one which is negatively electrified.

The two principal theories which were first advanced to account for these phenomena are known as the two-fluid theory and the one-fluid theory respectively. According to the two-fluid theory—advanced by Symmer—every material thing in the world contains an indefinite quantity of an imponderable fluid, which itself is compounded of two fluids. In combination these fluids are neutralised, but by friction they can be separated, and then become evident to our senses. Benjamin Franklin held that one fluid only existed, and that its particles were mutually repellant of one another. We have at present no definite theory to account for all the phenomena exhibited by electricity; but it is thought that the opinion held by Faraday—that explanation was to be looked for in the molecular condition of the bodies rubbed—is perhaps the most probable; and it is at all events pretty certain that electricity is one of the forms, capable of being transformed into other forms (such as Heat or Motion) of that mysterious Energy which, in one form or other, and chiefly by its very changes of form, does the work of the universe.

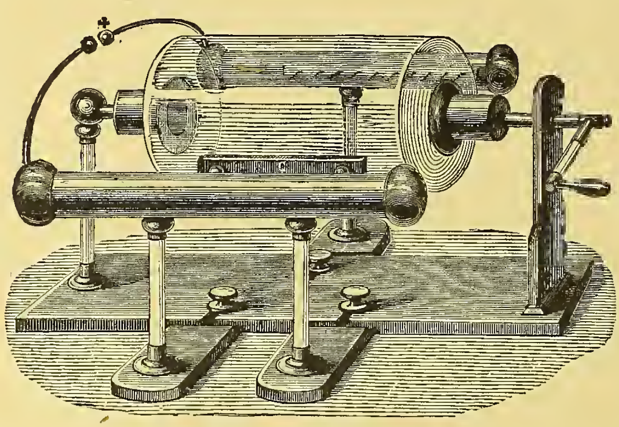


Fig. 3.—ELECTRIC MACHINE.

A far more sensitive form of electroscope is shown in Fig. 2. It consists of two leaves of gold, such as are used by gilders, attached by their ends to either side of a slip of brass. This contrivance is placed under an inverted glass jar, so that the delicate leaves cannot be disturbed by any gust of air. A brass wire passing from the slip of metal by which the leaves are supported, finds its exit through the cork of the jar, and is crowned with a little plate or table of the same material. This instrument is extremely sensitive, as can be shown by innumerable experiments. A rubbed glass rod held at some distance from the plate will cause the gold leaves to diverge, while a sealing-wax rod will cause them once more to fall. But the gold leaf electroscope will give evidence of being sensitive to far more delicate impressions than these. A lump of sugar, cut with a saw, and held in such a position that its dust will fall on the plate, will cause the leaves to separate. Coffee freshly ground from the mill will also give evidence of the electricity aroused in its particles by the friction of grinding. A little dry whiting or chalk urged upon the electroscope by being placed in the nozzle of a pair of bellows, will also show signs of electrical action. Even a disc of insulated cork, which has been warmed and merely pressed against a piece of the same material, will cause the leaves of the instrument to diverge. The fractured end of a broken rod of sealing-wax or sulphur presented to the plate gives a like result, while the crystals of many chemical salts show electrical excitation when heated and placed on the little brass table.

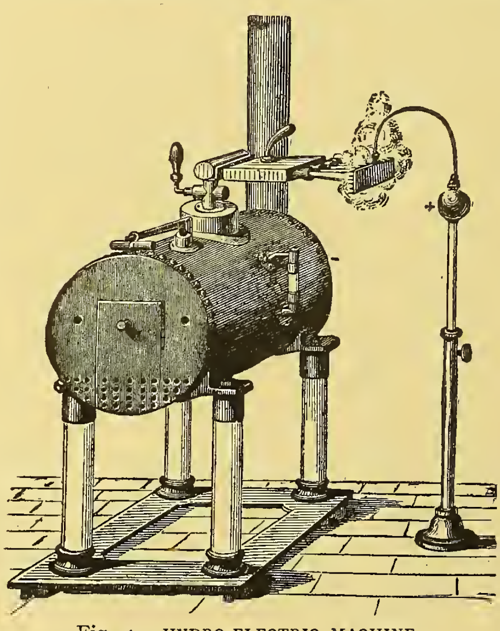


Fig. 4.—HYDRO-ELECTRIC MACHINE.

Seeing, then, that electricity is of so universal a character, and can be so readily made to give evidence of its presence, it is not surprising that many attempts were made to produce it in greater quantity by mechanical means. The first of these attempts must be credited to Otto von Guericke of Magdeburg, who made a machine in which the electricity was excited by holding a rotating ball of sulphur between the open palms. With this machine he was able to produce sparks and many other manifestations of electrical activity. Later on, glass was used in the same manner; and after several contrivances were in turn produced by different inventors, the survival of the fittest was exemplified in the well-known cylinder machine shown at Fig. 3.

Here we have the means of turning rapidly a cylinder of glass, against which is pressed a cushion of horsehair covered with leather. To increase the friction thus induced, the rubber is treated with an amalgam of mercury and tin. The electricity is collected by what is known as the prime conductor — a cylindrical metal body—supported on a glass stem, and furnished with a row of pointed wires, with their ends almost touching the revolving glass cylinder.

Another form of machine which is adopted when grander effects are desired is that known as the plate electrical machine. As its name implies, the cylinder is here replaced by a plate of glass. This plate, as it revolves, is pressed on each side by rubbers, and the electricity is collected by a prime conductor, as in the case of the cylinder machine. In small machines of this character, the glass plate has been superseded by a disc of vulcanite—which, on account of its lightness, is far more convenient for the purpose. Such machines as these last were introduced some years ago for mining purposes, where it was required to explode fuses by electrical agency.

Another machine, which caused much excitement when first exhibited in London many years ago, is the hydro-electric machine contrived by Sir W. Armstrong. The invention of this machine was due to a curious accident. It seems that at Sedgehill, near Newcastle, there happened to be standing a locomotive engine, which exhibited a fissure in the cemented joint by which the safety-valve was fitted to the boiler. Through this crack the high-pressure steam, of course, forced itself in a powerful jet. The engineer in charge found, to his surprise, that whenever he passed his hand through this jet he received an electric discharge, accompanied by a brilliant spark. Sir W. Armstrong was led to examine the cause of the phenomenon, and after a careful series of experiments, found that it was due to the friction of the particles of water against the sides of the aperture through which they escaped. Later on, he produced the hydro-electric machine just alluded to (Fig. 4).

This may be briefly described as a steam boiler with a series of bent iron tubes, terminating in jets made of partridge-wood—a material which was found by Sir W. Armstrong to ensure the best results. The watery steam from these jets impinged upon metallic points which were in connection with a prime conductor. Dry steam was found to give no effects whatever, and special precautions had to be adopted to keep the vapour in a saturated condition.

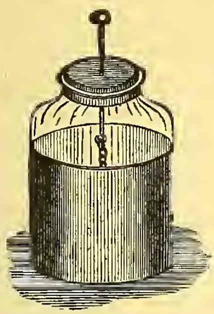


Fig. 5.—LEYDEN JAR.

Fig. 6.—DISCHARGER.

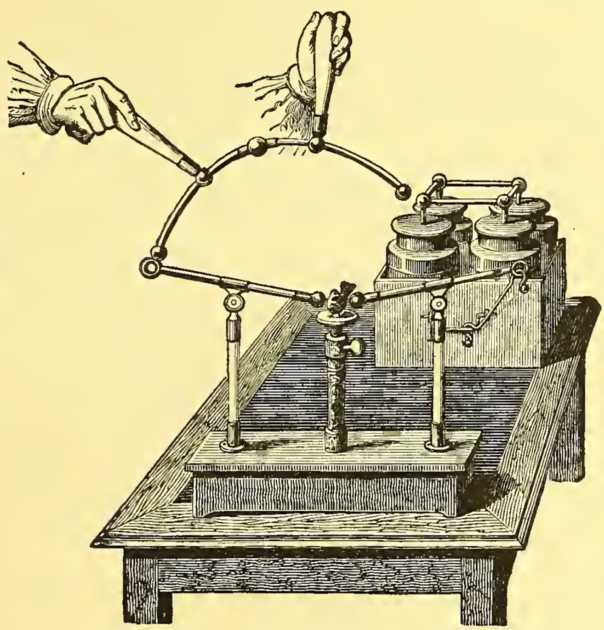


Fig. 7.—BATTERY OF LEYDEN JARS.

With all these machines, it is customary to store, or accumulate, the electricity by what is known as the Leyden jar (Fig. 5). This jar was first contrived by some experimenters at the town from which it takes its name. Its primitive form was a glass bottle, half filled with water—a nail being thrust through the cork, and touching the surface of the liquid. The idea was to solve that problem which is exercising the minds of so many workers in the present day—namely, the storage of electricity. The Leyden philosophers succeeded beyond their expectations; for one of them, holding the jar in his hand, and touching the nail with the other hand, received a smart shock. This shock may be said to have made itself felt throughout Europe, for the details of the experiment were speedily made known to the world. The jar as now made consists of a glass vessel, coated inside and outside to within an inch or two of its mouth with tin-foil. The mouth of the jar is closed with a cover of wood, through which passes a stout brass wire. Internal connection with the foil is ensured by the attachment of a piece of brass chain ; while the other end of the brass wire, outside the jar, is terminated with a brass knob.

The action of the Leyden jar can be readily understood by what has gone before. The knob of the jar being placed near the prime conductor of the electric machine, receives on its inner coating a charge of positive electricity. This induces a charge of negative electricity on the face of the outer coating nearest the glass ; so that the two opposite kinds of electricity are close together, but kept separate by the glass of the jar, through which they cannot pass. To discharge the jar, it is held in one hand, whilst the knuckle of the other hand is applied to the knob. If the jar be a large one, fully charged, this proceeding would be attended by danger, for the convulsive shock from a Leyden jar is by no means to be despised. It is therefore necessary to use the "discharger" shown in Fig. 6.

Where it is required to accumulate a large charge of electricity, a number of jars are joined together by their brass terminals, and they then form a Leyden Battery (Fig. 7). There was an immense battery of this description at the late Polytechnic Institution, in Regent Street. It consisted of fifty jars, each with a capacity of about five gallons. It was charged in about seventy seconds by the Armstrong hydro-electric machine. It is noteworthy that these immense jars, when sold with the other effects of the Institution, commanded the extravagant price of sixpence apiece.

Great care is necessary in manipulating batteries, as the shock from one of them may be very dangerous. One of the early experimenters relates that on one occasion he received the discharge through the top of his head : he fell down "in a heap," all nerveless, as if paralysed, though he recovered afterwards. He was certainly very fortunate in getting over his foolhardy experiment so well.

There are many other sources of electricity besides friction. It can be proved that the evaporation of a liquid is accompanied by the production of electricity ; and there is no doubt that atmospheric electricity owes its constant presence to this action. The crystallisation of all salts previously in solution also shows signs of electricity ; and in one instance at least is accompanied by flashes of light. The percussion of substances induces opposite electrical states in the striker and the matter struck. Pressure, vibration, combustion, cleavage, disruption—as we saw in the case of the broken sealing-wax applied to the electroscope—all give manifestations of electric action. In addition to these, we find that more than one living creature has the power of giving powerful and dangerous electric shocks—a power which it uses both for killing its prey and as a means of defence against its enemies. Even certain plants have been known to show signs of electricity. To the daughter of the great Linnæus is due the observation that in dry weather certain plants give out flashes of light—the marigold, nasturtium, and tiger-lily being noted as those commonly affected in this way. Another source of electricity is heat. The junction of two dissimilar metals, such as bismuth and antimony, when heated, will produce what is known as a thermo-electric current. But more important than any of these is the production of electricity by chemical action, as exemplified in the Voltaic battery, and by means of the magnet—as shown in those wonderful machines which are now coming into common use for electric lighting purposes. These machines, and the phenomena by which they are surrounded, will form subjects of future articles.

A MONSTER WATER-LILY.

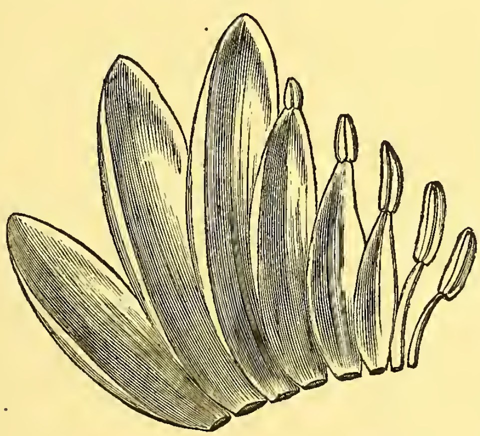
THE water-lilies form a small but very well marked group of plants, inhabiting still or gently running water in the temperate and tropical regions of both hemispheres. They have always commanded the admiration, at times created the wonder, and in one case at least, have even enjoyed the solemn religious respect of mankind. The large handsome flowers of the white water-lily—

"Rising in fearless grace with every swell,"

expanding during the day and closing at sunset, are familiar and striking summer objects in our ponds and sluggish streams. The gigantic Amazon-river water-lily, the famous *Victoria Regia*, has filled beholders with amazement since first it wonder-struck its discoverer in the still warm waters of its Brazilian home. The Sacred Lotus Bean, or Pudma, the most beautiful of all the water-lilies, is treated with the greatest and most profound veneration by the natives of India and China at the present day, and was so regarded at a period so remote as 4,000 years ago, by a particular sect of Egyptians now long ago extinct ; as is also their inviolable lily from the waters of the Nile, the plant having since then spread itself eastward over the warmer regions of Asia.

Altogether there are only about thirty or forty different species of water-lilies, two of which—the white and the yellow-flowered—are the only inhabitants of British pools and streams. They are of perennial habits, and most of them at least are provided with prostrate, submerged stems, often discovered creeping along the mud in shallow water. From these, stems and flowers are sent upwards carried on short stout stalks. The leaf-stalks are often attached to the centre of the under-surface of the generally roundish or heart-shaped blade, and these usually float on the surface of the water. In the Sacred Lotus, however, the leaves and flowers are carried upwards on long stalks to a considerable height, thus giving to it a gracefulness of form unpossessed by any of its aquatic relations.

The leaves before their expansion are characteristically folded by each lateral half of the blade, being unrolled from the margin to the central nerve or midrib. When fully grown and expanded the blade is generally large, being six or eight, or sometimes even ten inches in diameter, in our common white variety, but considerably larger than this in other individuals of the same family. The handsome and conspicuous flowers, borne solitary at the end of usually short leafless stalks, have several general, constant, and interesting points of structure. The sepals, or outer floral leaves, may be green or coloured, and the petals, numbering from three or five in some species to many times that number in others, may be either white, yellow, blue, or rose-coloured.



PETALS PASSING INTO STAMENS.

The stamens are always very numerous, and what is most interesting from a botanical point of view, the petals in a great many species may be seen gradually transforming themselves into stamens, the transition stages being represented in the annexed engraving. It was formerly believed that the flowers of our white water-lily sank beneath the water in the evening and rose again with the sun in the morning, the petals in this way retaining their spotless purity. Moore refers to this supposed habit in the lines—

> "Those virgin lilies all the night
> Bathing their beauties in the lake,
> That they may rise more fresh and bright
> When the beloved sun's awake."

The carpels, or seed-producing organs found in the centre of the flower, are often surrounded by a fleshy disk which gives a characteristic appearance to this part of the plant. In the Sacred Lotus the carpels are inserted in funnel-shaped cavities made in the broad top-flattened disk, each ripe carpel containing a single seed ; these become loose when ripe, and make a sharp rattle-like noise when the fruit containing them is shaken.

But the most remarkable species of this interesting family is undoubtedly the *Victoria Regia.* It is a monster plant with large orbicular leaves carried on very long floating stalks attached to and radiating from a submerged stem, and producing correspondingly large and strikingly handsome floating flowers. The leaves are often more than six feet in diameter, and many of them have their margins turned upwards, forming a circular rim from four to five inches high. The upper surface of the leaves are smooth and dark green, and the nerves, or veins, very indistinct ; on the under surface, however, the nerves are most prominent, coloured a clear red, and armed with rather long prickle-hairs. The stalks, or petioles, are several feet in length, and are also provided with long sharp prickles. In the substance of the leaf and petiole there are large air-cavities, not in communication, or at least not in direct communication with the exterior, and the possession of these give a surprising buoyancy to the leaves. In the aquarium at the Botanical Gardens at Ghent, some experiments were made a few years ago, to ascertain what weight the leaves of a *Victoria* they had growing there could support before they would be submerged. At first a child was placed on one of the largest leaves, then one of the gardeners reclined on the living float, but it was not until they had afterwards piled on bricks equalling in weight that of three men of average size, that the loaded leaves began to sink beneath the surface of the water. It is indeed said that Indian mothers coming down to bathe in the rivers where these lilies naturally grow, find the leaves most safe and convenient cradles wherein to lay their infants, during their usually lengthened stay in the water.

The flowers are first of a pure white colour, but they soon become tinged with rose, which in its turn quickly deepens in colour as the flowers approach maturity. They are fragrant, and sometimes measure as much as forty inches in circumference.

The plant is a native of the waters of the Amazon basin, and of the rivers of Guiana and La Plata, and was discovered in the year 1801 by the famous botanist Haenke, in the marshes by the side of the Rio Mamore. Haenke had been sent out by the Spanish Government to investigate the vegetation of Peru, and it is stated by a missionary who accompanied him, that his admiration for the "surpassingly beautiful and extraordinary" plant so transported him, that he "fell on his knees and expressed aloud his sense of the power and magnificence of the Creator in His works."

It was not, however, until 1837 that public attention was directed to this wonderful plant, by Sir Robert H. Schomburgk, who found it as he was journeying up the river Berbice in British Guiana, and who thus describes its discovery and the effect a sight of it produced upon his mind. "It was on the 1st of January, while contending with the difficulties Nature opposed in different forms to our progress up the river Berbice, that we arrived at a point where the river expanded, and formed a currentless basin. Some object on the southern extremity of this basin attracted my attention; it was impossible to form any idea what it could be, and animating the crew to increase the rate of their paddling, we were shortly afterwards opposite the object that had raised my curiosity—a vegetable wonder. All calamities were forgotten. I felt as a botanist, and felt myself rewarded: a gigantic leaf from five to six feet in diameter, salver-shaped with a broad brim, of a light green above and a vivid crimson below, rested on the water. Quite in character with the wonderful leaf was the luxuriant flower, consisting of many hundred petals passing in alternate tints from pure white to rose and pink. The smooth water was covered with blossoms, and as I rowed from one to the other I always observed something new to admire." This was in 1837, and it was shortly afterwards that this "sculpture-like and stately river queen," was imported into England and named Victoria—after and by permission of Her Majesty—but it was not until twelve years after that the plant was successfully introduced into cultivation, although many attempts had been made to induce it to grow. It is now, however, a thriving inhabitant of many a hot-house tank, and a fine specimen may be seen at any time during the summer at the Royal Gardens at Kew.

THE VICTORIA REGIA.

THE WONDERS OF THE HEART.

THE heart of any animal is simply a kind of *muscle*, and is therefore similar in its nature to the other "muscles" which form the flesh of our bodies. Such a declaration at once reveals to us a somewhat singular feature of the heart's action. It shows us that the heart, being simply a muscle, must work as do other muscles, and that the same force which moves our fingers in writing and grasping, or our legs in walking, circulates our blood. Every one knows that when muscles act, they contract or shorten themselves. For example, when we bend the fore arm on the upper arm, we are enabled so to do through the action of a well-known muscle, the *biceps*, just as, when we straighten the arm, it is the *triceps* muscle which performs the action. The biceps is enabled to bend the fore arm, because it has one end—the fixed extremity of the muscle—attached to the shoulder, whilst the other end—that which moves—is attached to one of the fore-arm bones. Hence, if we suppose the muscle to be at rest when the arm is straight, we can readily imagine that if the muscle grew shorter it would pull the fore arm nearer to the upper arm, or, in other words, would bend the arm. This power of shortening itself forms the property known as *contractility*, and the possession of it characterises all muscles.

Now the heart in the same way possesses the power of shortening its muscular fibres, and as a consequence, limits the size of the hollows or compartments it contains. In this way the fluid (or blood) in these compartments is forced outwards into the great pipes or blood-vessels which lead from them. This is one action of the heart; whilst when the fibres relax and the hollows of the heart expand once again, fresh blood enters therein, preparatory to the next contraction. The existence of the heart may thus be regarded as being spent between contracting and expanding. At first sight it might be thought that the heart worked incessantly. A poet has spoken of the heart as a "throbbing slave" which asks "no rest" whatever; but it is easy to show that in this case the poetic imagination has at least overstepped the bounds of reality. To understand the true state of matters concerning the heart and its work, we may make a series of easy calculations. These calculations will show us that the heart's work is not over-estimated, whilst the question of its rest will present none the less interesting features because of our knowledge of the activity of this curious organ.

In the adult man, the normal beat of the heart is from 70 to 75 times per minute. In the infant of a year old, it beats from 115 to 130 times per minute, but the frequency of its pulsations slowly diminishes until we arrive at the adult rate first mentioned. Then in old age it slows perceptibly, as might be naturally expected towards the end of life's duties. A very correct estimate of the heart's work has been made by the physiologist. This estimate shows us an amount of force and energy for which we would certainly be unprepared, unless through some previous acquaintance with the heart's work we were led to expect a large expenditure of power. The "unit of work," as it is named in England, is a convenient standard of power. It is defined as that amount of energy which is expended in raising one pound weight one foot high. Now, by accurate measurements of the heart's force, it has been calculated that in 24 hours a man's heart does an amount of work equal to 124 *foot tons.* In other words, if the whole force expended by the heart in 24 hours were gathered into one huge stroke, such a power would lift 124 tons one foot off the ground.

A similar calculation has been made respecting the amount of work executed by the muscles involved in breathing. In 24 hours, the latter are estimated to do work equal to 21 foot tons. One of the literal wonders of our frames may thus legitimately be regarded as consisting in the immense amount of work performed by the heart and by the breathing-muscles, when their work is summarised even for such a brief period as 24 hours.

But if the question of the heart's work is thus important, no less interesting is that of its *rest.* If we listen to the sounds of the heart by putting our ear to a person's chest, we may at once discover that two distinct sounds are made by the heart. The first is a long, dull sound, whilst the second sound is sharp and short. After the sounds comes a pause, and the length of the pause is about equal to that of the two sounds together. The causes of the sounds are known. They are produced by the flapping of certain *valves* which regulate the flow of blood through the heart. Now, as it can be proved that after every stroke of work, the heart's action is suspended—that is, after every sound of work there is a pause—the heart must *rest* periodically during its work. It is, in fact, in the position of a workman who takes short naps between short spells of work. And as physiologists have pointed out, the constitution of the heart would seem to point to such a combination of rest and work as that best fitted for the organ. We are apt to think of the heart as an organ which would require an immense deal of rest, but we are equally apt to forget that everything depends, after all, on the constitution of an organ. A clock, by its very mechanism, is adapted for a ceaseless round of duties such as it would be impossible for the steam-engine to perform. The engine requires a meed of rest and attention such as the clock does not demand. The heart is in the position of the clock. It is one of Nature's own pieces of mechanism, practically adapted to work incessantly, but also intended to take its periods of rest between its strokes of work. Considerations of this kind, whilst they remove much of the mystery attaching to the heart, only serve, at the same time, to show how wonderful are the facts which the scientific study of the heart reveals.

The human heart, as we have seen, is a hollow muscle. It is divided into two sides (right and left), and each side is again divided into two chambers. The chambers are situated, one at the upper extremity or base of the heart, and one (the larger of the two) below. The upper and smaller chamber of each side is called the *auricle* (L A and R A), whilst the lower and larger compartment is known as the *ventricle* (see illustration, R V and L V). Each side of the heart has a special duty to perform. The *right* side drives impure blood to the lungs to be purified, whilst the *left* side sends pure blood from the lungs outwards through the arteries to nourish the body. The upper chambers, or auricles, receive blood, and when they contract their fluid is thus sent into the ventricles. From these latter cavities the blood is then sent to the body and the lungs respectively. There exists in the heart, however, an admirable and wonderful apparatus of valves for controlling and directing the currents of blood through the organ. Thus between each auricle and ventricle exists a valve. The valve between the right auricle (R A) and right ventricle (R V) is the *tricuspid* valve (*a*); that between the left auricle and left ventricle being named *bicuspid* or *mitral valve.* Each valve consists essentially of three or two flaps; the extremities of the flaps (*a*) being attached, as shown in the figure, to projections arising from the interior wall of the ventricle. Thus when blood passes from, say, the right auricle (R A) into the ventricle (R V), the flaps fall back, like swing doors, and allow the ventricle to fill with blood. Then the flaps float upon the blood till they meet together, as represented in the figure (*a*). The delicate cords attaching the flaps to the wall of the ventricle prevent them from falling over into the auricle, and thus the blood is prevented, as by a kind of partition-wall, from going back into the auricle (R A). Then when the blood has been driven from each ventricle outwards into the blood-vessels, other valves, shaped like pockets (*b*), prevent its return into the heart. These pocket-like valves are named *semi-lunar* ("half-moon shaped") from their form. Each consists of three pockets placed in a circle at the entrance to the blood-vessel leading from each ventricle. That leading from the right ventricle of the heart is the *pulmonary artery* (P A), which carries blood to the lungs to be purified. The great vessel leading to the body from the *left ventricle* (L V) is the *aorta* (*Ao*), and semi-lunar valves also exist at the entrance to this latter tube, from which *arteries* (*ar*, *ar*) are given off to supply the body with pure blood. Each semi-lunar valve, consisting of three pockets as already mentioned, allows blood to pass into the vessel from the ventricle, as the pockets open away from the ventricle. If, however, the blood attempted to return into the ventricle the pockets would fill, and completely block up the way. When we reflect upon the intricate mechanism of the valves of the heart, and upon the regularity with which their duties are performed, we may well be inclined to regard the heart as one of the most perfect pieces of bodily mechanism that exists.

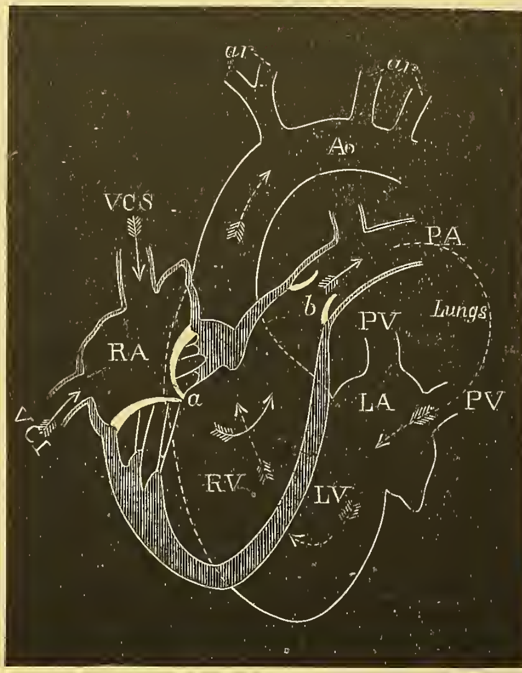


DIAGRAM OF THE HEART'S ACTION.

The course of the circulation may now be readily understood. The pure blood from the lungs is returned to the *left* auricle (L A) of the heart by the pulmonary veins (P V, P V). Thence it passes to the left ventricle (L V), which sends it to the body through the *aorta* (*Ao*). Becoming impure in the body, it is returned to the *right* auricle (R A) by the *venæ cavæ*, or great veins (V C S and V C I). Thence it is sent to the right ventricle (R V), which, in its turn, forces it through the pulmonary artery (P A) to the lungs for purification. Thus we again reach the commencement of the wondrous cycle of circulation which, as long as life lasts, is represented within our frames.

But lastly, the regulation and control of this wonderful pumping-engine form together a phase of its history of not the least remarkable kind. The heart, allowed to jog on its way peaceably and unrestrained, performs its duties with an unflagging vigour and punctuality. It may safely be affirmed, that the heart works best when left to itself. The proof of this statement is of two-fold nature. First, the experience of health shows us its truth; and secondly, we discover that the heart has been provided by nature with a set of nerves and nerve-masses destined to provide for its harmonious regulation. Specially distributed within its own substance, and intended for the regulation of its movements, we find a series of small nerve-masses and filaments. Scientifically, these nerve-masses are known as *cardiac ganglia*—a *ganglion* being simply a mass of nervous matter whence issue supplies of the peculiar force required for the regulation of life's actions.

Every reader is aware that the mind exercises more or less influence over the heart's movements. Such a statement only requires to appeal to our daily experience to receive full verification. Now, this outward influence of mind must spring from the brain and adjacent parts of the nervous system, as the seat of mind and of other complex actions proper to the controlling system of our bodies. Hence, as might be expected, very decisive evidence is forthcoming regarding the seat of the mind's action on the heart. One nerve, for example, is known to act as a *slower* and a *depressor* of the heart. Another nerve quickens its action. The former is to the heart what the bridle is to the horse—the latter is its spur. Thus, when the fleeting emotions of the mind pass across the mental atmosphere they undoubtedly affect the heart. Anger, fear, jealousy, and kindred passions either slow its action or kindle and quicken its pulsations into renewed vigour. Not always is this stimulation a healthy one.

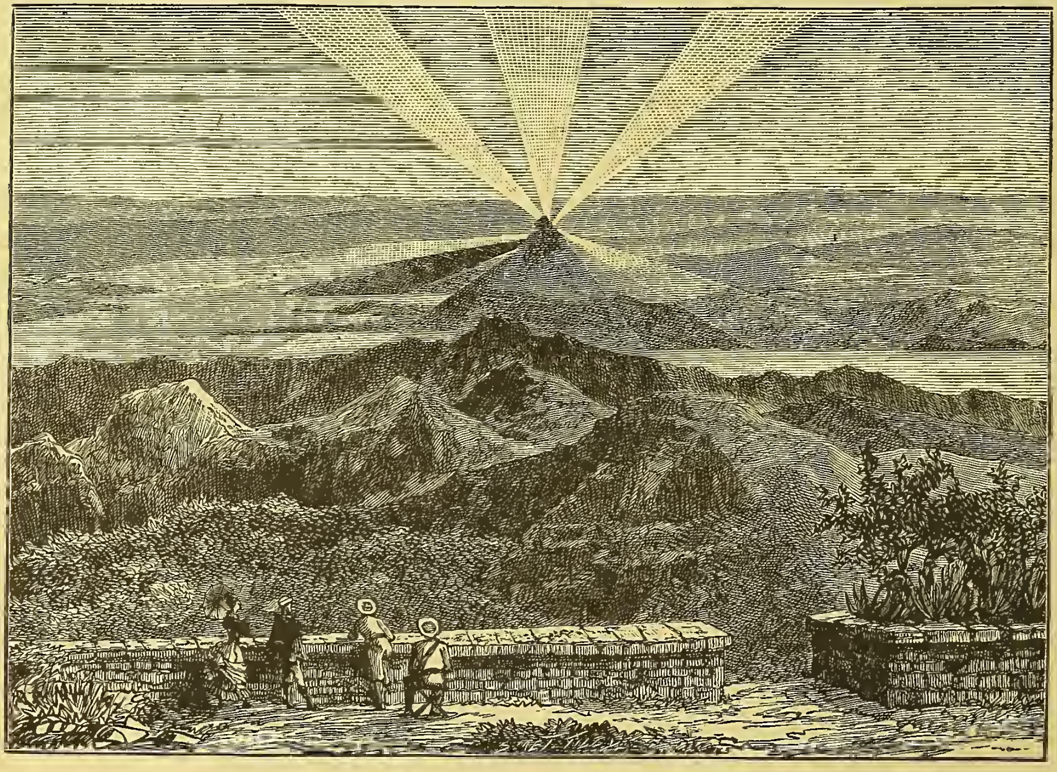
We may readily enough understand why the physiologist condemns in the strongest language the unrestrained play of passion or emotion. Each has its effect on the heart, and not always for the good of the organ. Thus the moral or religious teaching which urge us to place a restraint on passion, is supported throughout by the dicta of physiology; and the words of the Wise Man may thus receive a new reading and application, since physiology emphasises in the strictest fashion the well-known advice, "Keep thy heart with all diligence, for out of it are the issues of life."

BIRD AND INSECT WARFARE.

AMONGST the most curious records preserved in the British Museum is a pamphlet published for B. B., London (4to), 1622, which describes how, in the twelfth year of Richard II., at Shene, now called Richmond, the air was darkened for a time by an extraordinary cloud of gnats engaged in conflict so desperately, that the ground was thickly covered with their dead before a section of the whole, numbering about one-third, alone remained, as if victorious, and then suddenly dispersed. The same old work records a desperate engagement between starlings, which took place on the 12th of October, 1621, at Cork, in Ireland, and states that they were divided into what seemed like hostile camps, to which, during the previous four or five days, great numbers of these birds were observed flying, from east and west, some to one side, some to the other. Curiously enough the birds of each side avoided the others even in feeding—the westward camp seeking their food to the west of Cork, and that in the east seeking theirs eastward, not one flying within the circuits of the other. The day of their battle was the Saturday, and on the Sunday not a bird was visible, but on the next day the bird armies re-appeared, and the fight was waged as furiously as before. Strangely enough, on that same Sunday which divided their two great battles, a precisely similar battle was witnessed in England, at a place between Gravesend and Woolwich, when it was noted that a raven took its flight in a direct line between the contending armies. In each case large numbers of wounded and dead bodies were found on the house-roofs and in the streets underneath their aërial battlefields. In Cork they picked up amongst these a crow, a kite, and a raven. The writer of the pamphlet evidently inclines to the belief that the English armies and the Irish armies were the same.

In the Museum there is also preserved another pamphlet printed at Oxford in 1676, for J. Colley, which is described as a translation of one published originally at Lisle, on March 17th. This contains a very strange account of a prodigious gathering of birds between Dole and Salines, in the Franche Comté, on February 26th, 1676. These also fought in two distinct bodies with great fury and for some hours, and were composed of birds of all kinds, and the heaps of dead and wounded are said to have been high enough to reach a man's head in some places, and to have extended over an area of more than five hundred paces.

Certain insects also display wonderful skill in mustering and employing great armies in battle. The younger Huber, to whom we are indebted for many remarkable discoveries connected with insect life, has pointed out how regular armies of the wood-ant assemble, and wage war upon each other, not only in the most determined but also in the most systematic and scientific way, observing rules of warfare which seem to be devised in the most able manner. He says: "The warfare is conducted in various manners, according to the genius of the species engaged in it; and when a party of the wood-ants (*F. rufa*) attacks a party of the sanguine ant (*F. sanguinea*), the manœuvring reminds us strongly of our own battles." He adds: "Not the least wonderful circumstance connected with these insect battles is the instinct which enables each ant to know its own party." These battles are sometimes continued, with intervals of rest, for days.



SHADOW OF ADAM'S PEAK, FROM THE SUMMIT.

ADAM'S PEAK AND ITS SHADOW.

Adam's Peak is an object of more than ordinary interest to the traveller, because on its summit there is a gigantic footprint, to account for which there are various legends, and at dawn its elongated shadow, some four score miles long, behaves in the most mysterious manner. It is no wonder that the Cingalese regard the Peak, sometimes hiding its head in the clouds, with superstitious veneration.

The mountain rises like a sugar-loaf to a height of 7,420 feet above the level of the sea. It is about forty-five miles E.S.E. of Colombo, and commands a view of the island scenery of unexampled magnificence, which the Mohammedans have associated with our first parents, as they account for the footprint on its summit by saying that Adam impressed it there when taking his last look of Eden. The Hindoos say the impression was made by their god Siva; whereas the Buddhists, who have charge of the Peak, say that Buddha left his mark there, impressing his foot on the hard granite summit with as much ease as if it had been made of soft wax.

The so-called footprint is a hollow, resembling the form of a human foot, five feet four inches long and two feet six inches wide. Its margin is set with gems, and the Buddhists have railed it off and erected a wooden canopy over it. A priest is there to receive the offerings of both believers and unbelievers.

In the rather difficult climb to the summit of Adam's Peak, the traveller, wishing "to kill two birds with one stone," arranges to be on its summit before the sun rises, so that he may see the shadow of the mountain at daybreak rising with the sun until it is suddenly dispelled. Standing there on the top of the Peak and looking westward while the sun is rising, he sees an enormous shadow of the mountain projected over land and sea to a distance of seventy or eighty miles. As the sun ascends, the shadow appears to approach the mountain, rapidly rising above the spectator in the form of a gigantic pyramid of shade, projecting against a sort of cloud of vapour on the horizon. This is not all, however. Very often from the summit of the shadow there appear to project rays of constantly-changing form—sometimes like luminous smoke, and sometimes like the rays of the sun issuing from a cloud. Round these rays seem at times actually to gather all the stray patches of cloud or vapour to be seen near them in the sky, when they appear to glow with the most brilliant colours of the prism. The effect of these coloured rays of light, as seen in the illustration, is indescribably beautiful. And still, as the sun mounts towards the zenith and the shadow appears to fall back to the foot of the mountain, its blue or dark track is accompanied on each side by an aureola, or luminous border, which shows all the colours of the rainbow. This beautiful phenomenon is evidently due to diffraction, exalted in effect owing to some local peculiarity in the atmosphere, and which throws its coloured fringes on the light vapour in front as on a screen.

FROST FAIRS ON THE THAMES.

"I'll tell you a story as true as 'tis rare
Of a river turn'd into a Bartlemy Fair.
Since old Christmas last
There has bin such a frost,
That the Thames has by half the whole nation been crost."

Seventeenth Century Ballad.

AMONGST the most extraordinary of English weather records are those of long severe frosts, by which the Thames was so thickly frozen that fairs were held upon its surface. The first of these known as a Frost Fair was held in the year 695; and it seems probable that another was held in 760, when the frost continued from the 1st of October to the 26th of February; a third in 923, when the Thames was frozen for thirteen weeks; and a fourth in 998, when the river remained frozen five weeks. The Thames was again hard with frost in 1063, and continued so for fourteen weeks. Stow, in his "Annals," chronicles its being in the same condition "from Christmas to the Purification of our Lady" in 1281, when London Bridge was partially destroyed. In 1434 the river was

FROST FAIR ON THE THAMES IN 1683, FROM AN OLD PRINT.

frozen between the latter end of November and the beginning of February. It is most probable, although unrecorded, that on each of these rare and singular occasions a fair sprang up on the surface of the water. In 1564 another winter of extraordinary severity is mentioned in Holinshed's "Chronicle," when again the booths and sheds were erected on the Thames, and "people went ouer and alongst the Thames on the ise from London Bridge to Westminster. Some plaied at the football as boldlie there as if it had been on the drie land; diuerse of the Court being then at Westminster, shot dailie at prickes set vpon the Thames; and the people, both men and women, went on the Thames in greater numbers than in anie street of the Citie of London. On the third daie of January at night, it began to thaw, and on the fift there was no ise to be scene between London Bridge and Lambeth, which sudden thaw caused great floods and high waters, that bare down bridges and houses, and drowned manie people." Tradition states that Queen Elizabeth visited this fair.

Another account of a frost fair on the Thames figures in Edmund Howe's "Continuation of the Abridgement of Stow's English Chronicle," published in 1611. From this we learn that in 1608 the river, after being partially frozen over, became completely so "from Sunday the tenth of January vntill the fifteenth of the same," so that "all sorts of men, women, and children went boldly upon the ice in most parts; some shot at prickes, others bowled and danced, with other variable pastimes; by reason of which concourse of people, there were many that set vp boothes and standings vpon the ice as fruit-sellers, victuallers, that sold beere and wine, shoomakers, and a barber's tent," &c. He adds that all these had fires to warm them. Gough, in his "British Topography" (Vol. I., p. 731), mentions as very rare a tract published in London at the time of this frost, which contained an account of it, and also a rude woodcut representing the fair. It is called "Cold doings in London, except it be at the Lottery: with newes out of the Country. A familiar talk between a Countryman and a Citizen touching this terrible Frost, and the effect of them."

In the beginning of the December of 1683, a wonderful frost, which lasted until the 5th of February, 1684, again set up the sheds and booths on the fair in such abundance that in Maitland's "History" (Vol. I., p. 484) he describes the effect as that of "another city," in which, "by the great number of streets and shops, with their rich furniture, it represented a great fair, with a variety of carriages and diversions of all sorts; and near Whitehall a whole ox was roasted on the ice." Evelyn, in his famous "Diary," says of this strange city, "The frost continuing more and more severe, the Thames before London was still planted with boothes in formal streetes, all sorts of trades and shops furnish'd and full of commodities, even to a printing-presse, where the people and ladyes took a fancy to have their names printed, and the day and yeare set down when printed on the Thames; this humour tooke so universally that 'twas estimated the printer gained 5£ a day for printing a line only at sixpence a name, beside what he got by ballads, etc. Coaches plied from Westminster to the Temple, and from several other staires to and fro as in the streetes; sleds, sliding with skeets, a bull-baiting, horse and coach races, puppet-plays and interludes, cookes, tipling and other lewd places, so that it seem'd to be a bacchanalian triumph, or carnival on the water." From another old account written in verse, we glean that King Charles the Second, with his queen and her ladies and most of his courtiers, visited the fair, and had their names duly printed. One of these papers, now extremely rare and curious, formerly in the possession of Mr. William Upcott, of the London Institution, is in existence, on which the names figure as follow:—

Charles, King.
James, Duke.
Katherine, Queen.
Mary, Duchess.
Anne, Princesse.
George, Prince.
Hans in Kelder.

These names, thus arranged one below the other, are enclosed within an ornamental type border, and at the bottom we read "*London*: Printed by *G. Croom* on the ICE on the River *Thames*, *January* 31, 1684." The king is also reported to have passed one entire night on the ice, and to have taken part in hunting a fox upon it. Our view of this wonderful fair is reproduced from a contemporary drawing or woodcut, of which more than one copy is in the British Museum. In a broadsheet, the title of which is "Great Britain's Wonder, or London's Admiration," is mentioned "a street of booths," which extended from the Temple to Southwark. It has some doggrel verse, referring to the refreshment and coffee-booths, the printer "on the rocky ice," the "quaking watermen," who, like Othello, found their occupation gone, the bull and bear baiting, the fox-hunting, the taverns, &c., and says:—

> "Here also is a lottery too; music too;
> Yea, a cheating, drunken, lewd, and debauched crew
> Hot codlins, pancakes, ducks, and goose, and sack,
> Rabbit, capon, hen, turkey, and a wooden jack."

Other rhymes, which appear in another rude contemporary record, tell us that—

> "——coffee houses in great numbers were
> Scattered about in this cold-freezing fair.
> There you might sit down by a char-coal fire,
> And for your money have your heart's desire:
> A dish of coffee, chocolate, or tea."

From December to March, 1709, was the reign of another mighty frost, but the London Frost Fair was then so short and so poor a one, that beyond a bill purporting to have been printed on the Thames at Westminster by "Mr. John Heaton" on January 7th, we have no record of it.

About the end of November, 1715, however, a frost of greater severity set in, which continued until the ninth of the following February, when all the sports, pastimes, and buying and selling of 1683 were renewed, and vigorously kept up. Of this several engravings on wood and copper are in existence. One, "Printed and Sold by John Bowles, at the Black Horse in Cornhill," is called "Frost Fayre, being a True Prospect of the Great Varietie of Shops and Booths for Tradesmen, with other curiosities and humors, on the Frozen River of Thames, as it appeared before the City of London in that memorable Frost in ye second year of the Reigne of Our Sovereigne Lord, King George, Anno Domini 1716."

On Wednesday, December 26th, 1739-40, another remarkable frost solidified the Thames, and Frost Fair again began its wildly turbulent and merry reign. In Vol. X. of the old *Gentleman's Magazine* we are told that the river represented "a snowy field, everywhere rising in masses and hills of ice and snow," of which many drawings were made. On this occasion booths, printing-presses, roasting oxen, and shows uprose again. It was in this fair that "Doll, the Pippin-woman," lost her life, and was immortalised in Gay's "Trivia." The event was therein thus described :—

"Doll every day had walk'd these treacherous roads ;
Her neck grew warp'd beneath autumnal loads
Of various fruit ; she now a basket bore :
That head, alas ! shall basket bear no more.
Each booth she frequent pass'd in quest of gain,
And boys with pleasure heard her thrilling strain.
Ah, Doll ! all mortals must resign their breath,
And industry itself submit to death.
The crackling crystal yields, she sinks, she dies,
Her head, chopt off, from her lost shoulders flies ;
'Pippins,' she cried, but death her voice confounds,
And 'pip-pip-pip' along the ice resounds."

Another of Old London's remarkable characters, whose portrait and history figures in *Old and New London*, "Tiddy Doll," died in the same place and manner, as did many others. Some of the newspapers which record this fair stated that its attractions had emptied the theatres. Numerous illustrations of it were printed on the ice from copper plates, and sold, mostly at sixpence each. One has the following verse :—

"Amidst y^{e} arts y^{t} on y^{e} Thames appear,
To tell y^{e} Wonders of this frozen Year.
Sculpture claims Prior place, since y^{t} alone
Preserves y^{e} Image when y^{e} Prospect's gone."

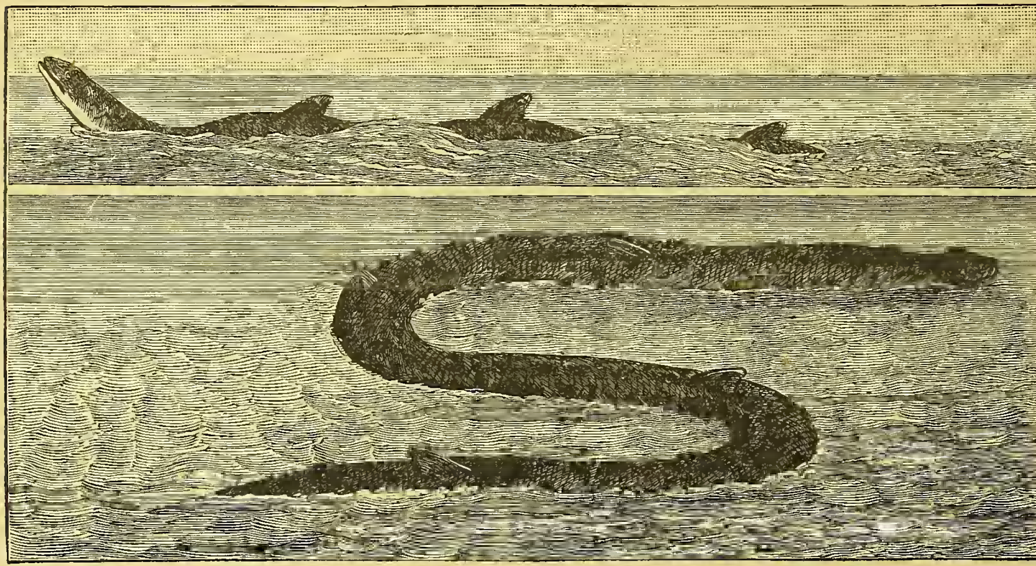
The *Daily Post* of Tuesday, January 22nd, thus notices the breaking up of this extraordinary frost :—"Yesterday morning the inhabitants of the West prospect of the Bridge were presented with a very odd scene, for on opening their windows, there appeared underneath, on the River, a parcel of booths, shops, and huts of different forms, and without any inhabitants, which, it seems, by the swell of the waters and the ice separating, had been brought down from above. As no lives were lost, it might be viewed without horror. Here stood a booth with trinkets, there a hut with a dram of old gold ; in another place a skittle-frame and pins ; and in a fourth 'the Noble Art and Mystery of Printing, by a servant to one of the greatest trading companies in Europe.' With much difficulty, last night, they had removed the most valuable effects."

In the great frost of 1785, which extended over 115 days, and was of extreme severity, booths re-appeared upon the ice, with many thousands of persons, as they did again in 1789, when regular passages across the ice were made with ashes at Gun Dock, Execution Dock, &c. A January number of the *London Chronicle* says :—"No sooner had the Thames acquired a sufficient consistency than booths, turn-abouts, &c. &c., were erected ; the puppet-shows, wild beasts, &c., were transported from every adjacent village ; while the watermen, that they might draw their usual resources from the water, broke in the ice close to the shore, and erected bridges with toll-bars, to make every passenger pay a halfpenny for getting to the ice. One of the suttling booths has for its sign, 'Beer, Wine, and Spirituous Liquors without a Licence.' A man who sells hot gingerbread has a board on which is written, 'No shop-tax nor window duty.' All the adventurers contend in these short sentences for the preference of the company, and the Thames is in general crowded." The *Public Advertiser* of Thursday, January 15th, quotes from a board over one of the temporary shops these words, "This Booth to Let. The present possessor of the Premises is Mr. Frost. His affairs, however, not being on a permanent footing, a dissolution or bankruptcy may soon be expected, and the final settlement of the whole entrusted to Mr. Thaw." Printing-presses were again set up, and from one, the property of William Bailey, emanated the following lines, which re-appeared in the great frost fair of 1814 :—

"The silver Thames was frozen o'er,
No diff'rence 'twixt the Stream and shore ;
The like no Man hath seen before,
Except he liv'd in Days of Yore,"

the days which, in that case, existed four years before. On this occasion they roasted a pig and hunted a bear on the ice. The ice by Blackfriars was eighteen feet in thickness. "The various parts of the River," said the *Daily Advertiser* of January 9th, "present different appearances ; in some the surface is smooth for a mile or two, and then rough and mountainous, from the great quantities of snow driven by the wind and frozen in large bodies." The same paper, describing the condition of the Thames at Putney, says:—"Opposite to Windsor Street, booths have been erected since Friday last, and a fair is kept on the river. Multitudes of people are continually passing and re-passing; puppet-shows, roundabouts, and all the various amusements of Bartholomew Fair are exhibited. In short, Putney and Fulham, from the morning dawn till the dusk of returning evening, are a scene of festivity and gaiety." The thaw set in on Tuesday, January 13th. The *Daily Chronicle* says:—"The breaking up of the Fair upon the Thames last Tuesday night, below Bridge, exceeded every idea that could be formed of it, as it was not until after the dusk of the evening that the busy crowd were persuaded of the approach of a thaw. This, however, with the cracking of the ice about eight o'clock, made the whole a scene of the most perfect confusion, as men, beasts, booths, turnabouts, puppet-shows, &c. &c., were all in motion, and pouring towards the shore on each side. The confluence here was so sudden and impetuous, that the watermen who had formed the toll-bars over the sides of the river, not being able to maintain their standard from the crowd, &c., pulled up the boards, by which a number of persons who could not leap, or were borne down by the press, were soused up to the middle. The difficulty of landing at the Tower Stairs was extreme, until near ten o'clock, occasioned by the crowding of people from the shore, who were attracted by the confusion on the water. The inconvenience to the shipping is now increased more than since the setting in of the Frost, as no person will venture upon the ice to fetch or carry anything for them, and it is not yet sufficiently disunited for a boat to live." The Thames, however, was quickly re-frozen.

The last Frost Fair was celebrated in the year 1814, when a severe frost set in on the 27th of December, and lasted until the 5th of the following February. There was then a grand mall, or walk, lined on either side with sheds and booths, extending along the centre of the river from Blackfriars to London Bridge, and called "The City road." Kitchen fires and furnaces blazed in every direction; donkeys were brought on the ice for hire; gambling, drinking, and feeding abounded; the watermen re-established their toll-bars; skittles were played, and tents set up for dancing; laughter, singing, and music, shouts, and a Babel of varied noises filled the air; tea and coffee were in great demand; and the printing-presses were once more at work. One of the booths was thus advertised: "This Shop to Let. N.B.—It is charged with no *land* tax, or even *ground* rent."



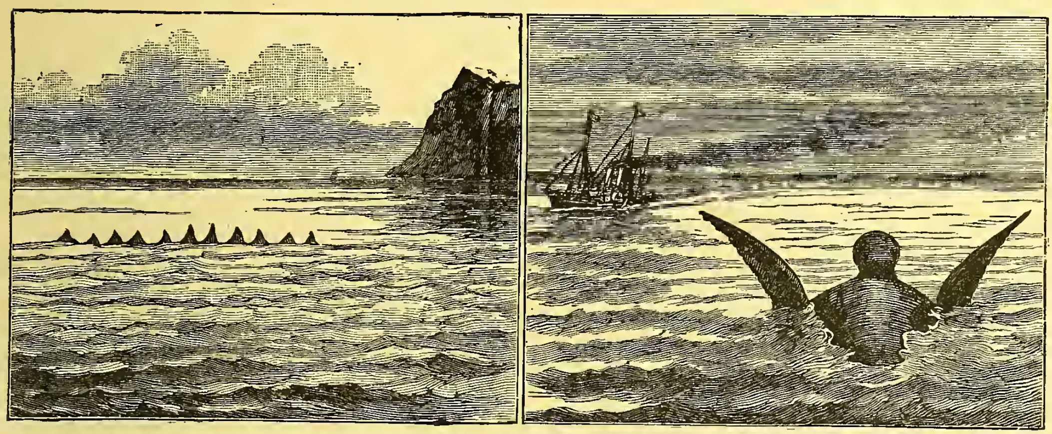
THE SEA-SERPENT, AS SEEN OFF GALVESTON IN 1872.

THE SEA-SERPENT.

Is the great sea-serpent which we have so often heard about a reality, or a myth? The tradition seems to possess a vitality which defies extinction. During every succeeding "dull season" the serpent seems regularly to take up its position in the newspapers, in company with the colossal gooseberry and other abnormal productions of nature. Can there be after all any substratum of truth in the oft-repeated tale? We cannot at once set aside the question of the existence of the great unknown as an absurdity not worth consideration, because there is abundant testimony by respectable witnesses that monsters of the kind have been actually seen. It is impossible—indeed it would be impertinent to assume—that so many people could be induced to affirm, and in many cases to testify upon oath, to that which they know to be false. Neither can we hurriedly admit that intelligent people could be altogether mistaken as to the evidence of their own senses, particularly as many accounts describe the appearance of the creature at close quarters. There is no doubt whatever that *something* has been seen—and often seen—but what this something can be, if not a serpent, it is very hard to guess. Let us examine a few of these sea-serpent stories, and judge for ourselves of their truth.

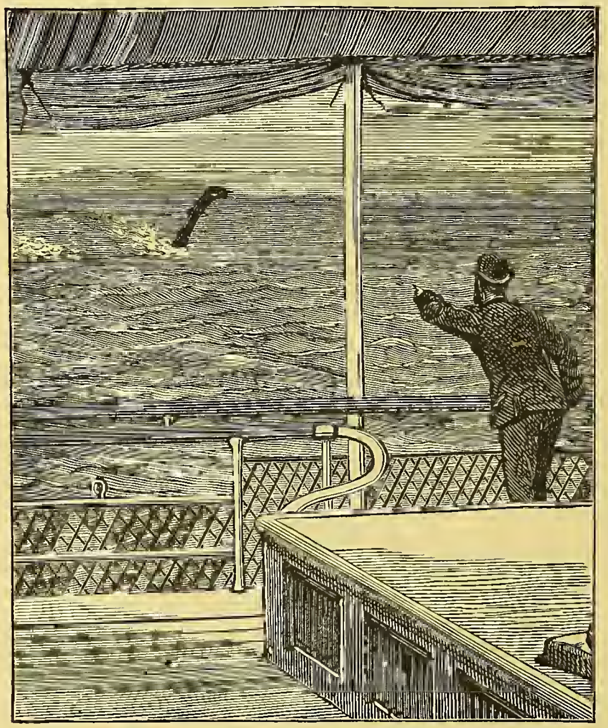
In a Latin book by Gesner, dated 1620, we find an account of two different kinds of sea-serpent. The one is described as being 30 to 40 feet long, and to be quite harmless unless provoked, when it will turn upon its assailants. The other one is a far more terrible creature, found upon the coast of Norway. It measures 100 to 300 feet in length, and has the disagreeable habit of seizing an unsuspecting sailor from the deck of a ship, or even enveloping in its gigantic embrace the vessel itself, and dragging it to the bottom of the sea. The author of this account also describes how the folds of the animal's body often form arches above the surface of the sea through which a good-sized vessel can easily sail.

The tradition of a sea-serpent near Norway seems to be well established, and the animal is described at length by Pontoppidan, Bishop of Bergen, in his Natural History of that country. He gives its length as being 100 fathoms (600 feet), and describes it as having been seen by many observers at different times. The head, in all the kinds, has a high and broad forehead, but in some a pointed snout, though in others it is flat, like that of a cow or horse, with large nostrils, and several stiff hairs standing out on each side like whiskers. The eyes of this creature are very large, of a blue colour, and look like a couple of bright pewter plates. The whole animal is of a dark-brown colour, but "speckled or variegated with light streaks or spots, which shine like tortoise-shell." This terrible creature is further described as being dangerous to navigators, as it occasionally will throw itself upon a ship and sink it by its great weight. The way to guard against it is to keep at hand some castor oil, the smell of which it will avoid. The good bishop believed this Norwegian monster to be identical with the Leviathan of scripture. So much for "travellers' tales" of the past. Let us now see how far they are corroborated by those of the present.



THE SEA-SERPENT, AS SEEN FROM THE "OSBORNE" IN 1877.

In the *Times* newspaper of the 9th of October, 1848, appears an account of an enormous sea-serpent which was seen by the captain and most of the officers and the crew of H.M.S. *Dædalus.* This ship was on its way home from the East Indies, when the monster was sighted between the Cape of Good Hope and St. Helena. Captain McQuhæ, who commanded the ship, supplies the narrative. He describes the animal as "an enormous serpent with head and shoulders kept about 4 feet constantly above the surface of the sea, and as nearly as we could approximate by comparing it with the length of what our main-topsail-yard would show in the water, there was at the very least 60 feet of the animal, no portion of which was to our perception used in propelling it through the water, either by vertical or horizontal undulation." The captain adds that the animal passed so closely by the ship that, had it been any man of his acquaintance, he must have recognised him without the aid of a glass. The next example is of twenty years later date, and was supplied to the *Graphic* by a well-known Liverpool shipowner, who signed the statement as a witness to the writer's identity. It is the report of Captain A. Hassel, of the barque *St. Olaf*, from Newport to Galveston, Texas. It runs as follows: "Two days before arrival at Galveston, and at 4 p.m. on May 13 (1872), weather calm, smooth sea, lat. 26° 52′, long. 91° 20′, I saw a shoal of sharks passing the ship. Five or six came under the vessel's stern, but before we could get out a line they went off with the rest. About two minutes after, one of the men sang out that he saw something on the weather bow like a cask on its head. Presently another one called out that he saw something rising out of the water like a tall man. On a nearer approach we saw that it was an immense serpent, with its head out of the water, about 200 feet from the vessel. He lay still on the surface of the water, lifting his head up and moving the body in a serpentine manner. We could not see all of it, but what we could see from the after-part to the head was about 70 feet long, and of the same thickness all the way, excepting about the head and neck, which were smaller, and the former flat like the head of a serpent. It had four fins on its back, and the body of a yellow, greenish colour, with brown spots all over the upper part, and underneath white. The whole crew were looking at it for fully ten minutes before it moved away. It was about 6 feet in diameter. One of the mates has drawn a slight sketch of the serpent which will give some notion of its appearance." We need not comment upon this account except to notice that the markings of the animal — "yellow, greenish colour, with brown spots"—have a strange similarity to the tortoise-shell appearance of the serpent described by Pontopiddan already alluded to. Another report of a sea-serpent was declared to on oath before the magistrate at the Liverpool Police Court by the master and five of the crew of the barque *Pauline* (of London). This statement describes how, on July 8, 1875, they "observed three large sperm whales, and one of them was gripped round the body with two turns of what appeared to be a huge serpent. The head and tail appeared to have a length beyond the coils of about 30 feet, and its girth 8 or 9 feet. The serpent whirled its victim round and round for about fifteen minutes, and then suddenly dragged the whale to the bottom, head first." On a subsequent occasion the same serpent, or one like it, was seen by three of the crew "elevated some 60 feet perpendicularly in the air."



AS SEEN FROM THE "CITY OF BALTIMORE" IN 1879.

We now come to an appearance which was seen off the coast of Sicily in June, 1877. Lieut. Haynes, of H.M.S. *Osborne*, writes as follows:—"My attention was first called by seeing a long row of fins appearing above the surface of the water at a distance of about 200 yards from the ship, and away on our beam. They were of irregular heights, and extending about 30 or 40 feet in line. (The former number is the length I gave, the latter the other officers.) In a few seconds they disappeared, giving place to the fore-part of the monster. By this time it had passed astern, swimming in an opposite direction to that we were steering, and as we were passing through the water at ten and a half knots, I could only get a view of it 'end on,' as shown in the sketch. The head was bullet-shaped, and quite 6 feet thick, the neck narrow, and its head was occasionally thrown back out of the water, remaining there for a few seconds at a time. It was very broad across the back or shoulders, about 15 or 20 feet, and the flappers appeared to have a semi-revolving motion, which seemed to paddle the monster along. They were about 15 feet in length. From the top of the head to the part of the back where it became immersed, I should consider 50 feet, and that seemed about one-third of the whole length. All this part was smooth, resembling a seal. I cannot account for the fins, unless they were on the back below where it was immersed."

Less than two years after the above circumstantial narrative was published, the great unknown once more made its appearance. This time it was seen from the steamship *City of Baltimore*, in the Gulf of Aden, by Major H. W. J. Senior, of the Bengal Staff Corps. This gentleman executed a sketch of the monster, which was afterwards reproduced in the *Graphic* of April 19, 1879. The narrator describes how, on the 28th of January, in the same year, at 10 a.m., he observed a long black object at a distance of about three-quarters of a mile from the ship, darting rapidly in and out of the water, and advancing nearer and nearer to the vessel. The observer thereupon shouted out "Sea-serpent! sea-serpent!" attracting the attention of the captain of the ship and others, who were fortunate enough to catch a sight of the creature. The serpent on this occasion was only 500 yards from the ship, on a bright sunny morning, so that it could be observed under the best conditions. Major Senior writes:—"The shape of the head was not unlike pictures of the dragon I have often seen, with a bull-dog appearance of the forehead and eyebrows. When the monster had drawn its head sufficiently out of the water, it let itself drop as it were like a huge log of wood, prior to darting forward under the water. This motion caused a splash of about 15 feet in height on either side of the neck, much in the shape of a pair of wings."

The last account of the sea-serpent which we can find appeared in *Nature* of June 24, 1879. This is in the form of a letter from a clergyman at Busselton, a little seaport on the west coast of Australia. This gentleman describes how he saw, close to the shore, a serpent which appeared to be about 60 feet long, "straight and taper, like a long spar with the butt-end—his head and shoulders—showing well above the water."

Other sea-serpent narratives have been explained away satisfactorily: sometimes a long straggling mass of seaweed has, to a heated imagination, taken the form of a serpent, and the motion of the waves has given it the necessary vitality. We have also before us the records of two appearances which showed a distinct serpentine form of enormous dimensions. In these cases examination with a good glass proved that the monsters were made up of myriads of birds in rapid motion. But the stories that we have quoted at length cannot be dismissed in such a cursory manner. They are by no means the only ones of the kind; and in some at least of such narrations the observers appear to have been too close to the object seen, and to have had it too long within view, to be easily mistaken. The only reasonable conclusion that we can come to is that a marine monster exists, but as to its nature we can only hazard conjectures.

Sea-snakes of from three to twelve feet in length are found both in the Indian and Pacific Oceans. They feed on fish, and, although of a most poisonous nature, are rarely fatal to human beings, for the simple reason that they are shy, and swim away at the least alarm. Even in British waters a small species is found, called the Red Band fish, or snake fish, measuring from 18 to 20 inches in length. After a storm, in 1839, the coast of Devonshire was strewn with many specimens of this fish. Now in every department of nature we find eccentricities of form, and instances of gigantic stature. Cuttle-fishes, as we have seen, are now known to reach a size which, until lately, would have been regarded as altogether fabulous. Why should not the sea-snake occasionally exhibit a like tendency?

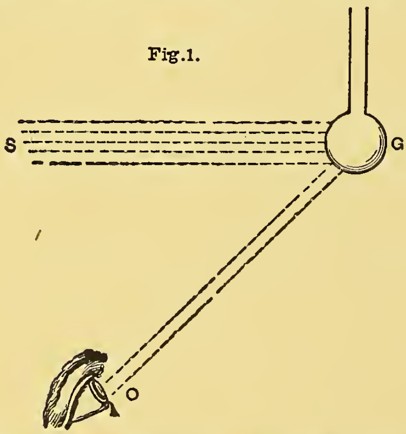
There is another possibility. Some of the recorded appearances closely correspond with that of several of the extinct reptilian monsters. If some of these—such as the Plesiosaurus with its long neck and tail—still survived, and were of large dimensions, the descriptions published would be but little exaggerated; and, indeed, some of the recorded details, such as the fins or flappers mentioned in some accounts, correspond better with such an animal than with a real snake. Some naturalists are therefore disposed to think that such forms, or others closely allied to them, may *not* be "extinct" as supposed. It is at least very remarkable that the old legends of gigantic cuttle-fishes should only lately have been verified; and it is possible that a similar process may be in store for the present case.

We cannot do better than conclude our remarks by quoting the summing-up of an article on this subject by Dr. Andrew Wilson, the well-known zoologist. He concludes:—"Firstly, that many of the tales of sea-serpents are amply verified when judged by the ordinary rules of evidence; this conclusion being especially supported by the want of any *primâ facie* reason for prevarication. Secondly, that laying aside appearances which can be proved to be deceptive, and to be caused by inanimate objects, or by unusual attitudes on the part of familiar animals, there remains a body of evidence only to be explained on the hypothesis that certain gigantic marine animals at present unfamiliar, or unknown to science, do certainly exist; and, thirdly, that the existence of such animals is a fact perfectly consistent with scientific opinion and knowledge, and is most readily explained by recognising the fact of the occasional development of gigantic members of groups of marine animals already familiar to the naturalist."

THE RAINBOW AND THE SPECTRUM.

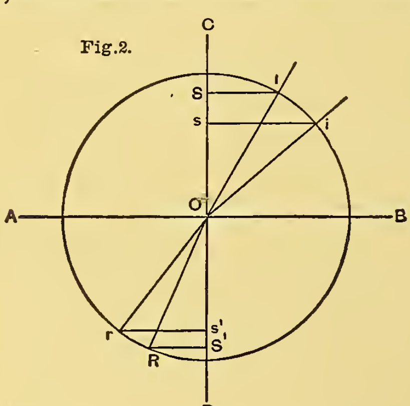
MOST of the many magnificent phenomena of optics require some little apparatus to observe them; but the most beautiful of all is familiar to every one of us, and must have challenged attention from the very earliest ages. It must soon have been discovered that rainbows were only visible when

Fig.1.



the observer was placed between the sun and a shower of rain, but the ancients do not seem to have known anything beyond this; and the very earliest approach to any explanation that is known was made in 1311 by a Dominican friar, named Theodoric, who gave diagrams of both a single and double reflection of the sun's rays within a drop of water, which show that he had a true notion to a

Fig.2.



certain extent of what occurred. But there were no printing presses or periodicals then to explain the "World of Wonders," and as no one knew what had been thought out by Theodoric till some hundreds of years after him, the philosophers were all quite astray in their attempts to explain the beautiful bow.

About the year 1600, however, another churchman, Antonio de Dominis, made a very simple and beautiful experiment. Taking a hollow glass globe filled with water to represent a spherical drop of rain, he placed it in the sun's rays, to see how it behaved, as we may do to-day with one of those penny water-microscopes often sold in the streets. Letting the rays from the sun, S (Fig. 1), fall upon the globe at G, he found that when the eye of the observer at O was so placed that the reflected and refracted ray G O made the angle S G O about 40°, the ray appeared blue; and that when the eye was moved a very little lower down, or the globe was moved up

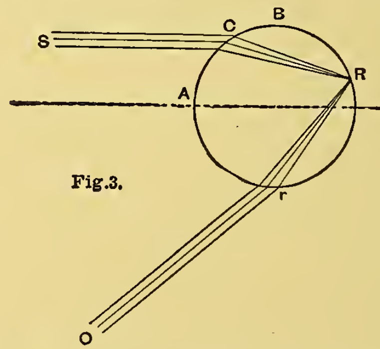


Fig.3.

so as to make the angle 42°, the light was red. Finding these angles were always the same, he reasoned very correctly that if there were a number of small drops between the two positions, all the colours would be seen in their proper places at the same time, and that there ought from a shower of rain to appear a circular arch of all the colours, the diameter of the bow making the doubled angle of 80° to 84° with the eye. The rainbow, it was found, did subtend exactly that angle from the eye of the observer. De Dominis does not seem to have had a very

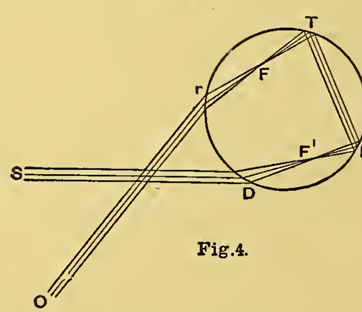
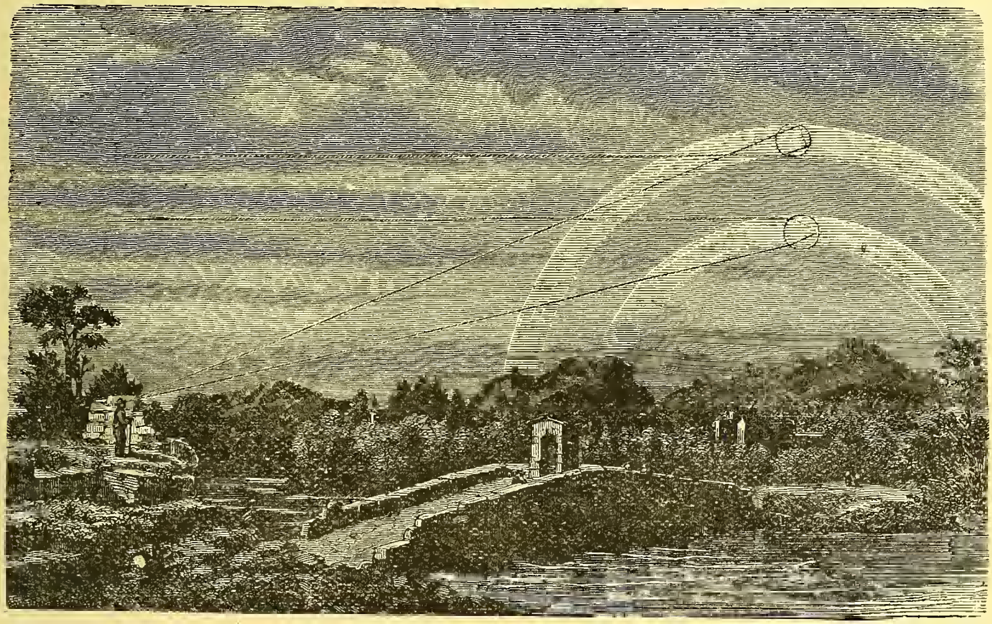


Fig.4.

clear idea of the course of the sun's rays, though his general idea was not far from the truth; but he certainly did find out, and show by actual experiment, that the beautiful phenomena could be traced out in a single transparent globe of any kind, and that the "bow" resulted simply from the great number of drops of rain.

Descartes, in 1637, showed why the bow could only occur at the particular angle of 40° to 42°. He worked this out from the simple and beautiful law of refraction, discovered seven years before by Snell.

Supposing A B (Fig. 2) is a surface of water or other refractive medium, and C D a perpendicular to it; let a ray of light, I O, strike obliquely upon the water at O: it will be refracted or bent, say to R. Let another ray strike more obliquely, as at *i* O; it will be bent say to O *r*. Describing a circle from O, where the rays strike the surface, let fall on the perpendicular C D, from where all these rays cut the circle, perpendiculars to C D, as I S, *i s*, R S′, *r s′*. These lines are what geometers call the "sines" of the angles made by each ray with C D; and it is found that in water or anything else, whatever is the proportion of the sine I S to and are more and more bent; and there must be some point at C where a parallel bundle of rays are just brought to one point, or "focussed," at R on the back side of the drop. Striking obliquely there also, these focussed rays are in great part reflected; when they must diverge at the same angle as they converged, and finally be refracted out again at *r* back to the eye at O, very nearly parallel, as they entered at C. At other angles the light, not being accurately converged to R, must be, with one exception to be noticed, scattered or dispersed. It was soon calculated that in water the angle between S and O must be about 40°.



THE RAINBOW.

the sine R S′ of its refracted ray, there is *exactly the same* proportion between the sine *i s* of any other incident ray and the sine *r s′* of its refracted ray. Therefore, whenever we know how much one particular ray is bent aside or refracted, in water, glass, or any other substance, we can calculate exactly how much any other ray will be bent: as, for instance, where a ray will go to which passes in any direction, and at any point, through a drop of water, or any other form of lens.

This was what Descartes learnt from Snell; and applying it to the rain-drop, he soon found why we see the rainbow just of the size (or angle) we do, and nowhere else. If the rays struck the drop perpendicularly, at A (Fig. 3), they would, of course, go straight through, and we should see nothing. As they strike more from A towards B, they meet the surface of the drop more and more obliquely,

The outer bow, so constantly seen when a rainbow is bright, was explained by Descartes in the same way, from the exception mentioned above. Taking another rain-drop, as in Fig. 4, he found by calculation that there was another point, D, farther from the centre than in the other case, at which a parallel bundle of rays from S would be converged to such a point or focus, F′, that the rays again diverging from that focus would be brought nearly parallel when *reflected* from the hollow surface of the drop at R, which acts like a small concave mirror. This parallel beam is again reflected at T and further converged by the hollow surface to a focus F, and thence refracted out of the drop at *r*. There being a second reflection in the drop for these rays, the bow must be fainter and the order of the colours inverted; and the calculated angle between S and O was from 50° to 54°. This is just the angle of the outer bow; and the coloured light, or the coloured images of a candle, can be seen also by experiment in the globe of water, or even in such a plain globular carafe of water as is found in many bedrooms.

But Descartes only showed why a bright semicircular appearance of *some* kind must be seen where the rainbow was seen. The colours were still a mystery, until Newton made his famous discovery of the dispersion or decomposition of white light, and proved that it was broken up into colours by refraction. His grand discovery was, that this happened simply because one colour is more or less bent than another. If all colours were bent alike, then a ray of white light, after refraction, would still be white; and as any difference is not easily seen in small refractions, people had hitherto, without reflection, supposed that it was so. Newton, however, wanted to find out more about the bending aside of rays of light; and as in entering a denser substance the oblique ray is bent *towards* the perpendicular, and in passing out of it into air is bent *from* the perpendicular, he took a piece of glass with inclined faces, called a "prism," so that the bending might be doubled. He let the light from the sun at S pass through a small hole in the shutter of a dark room into the prism P, striking it at A, Fig. 5. The whole ray was bent away from K on the floor, up to H I. But this was the curious thing about it: the red part of the light was only bent to *r*, while the orange was *more* bent to *o*, and the yellow farther up to *y*, and so on, till the violet was bent up to *v*. Thus the ray of white light was drawn out into a "spectrum," showing "all the colours of the rainbow;" and finally, Newton showed that if we took all these separate colours and gathered them into one spot again, they made white light. The rainbow was now all cleared up; because when the sun's rays were bent on entering and leaving each drop, the blue rays were in just this same way *more* bent than the red rays. Everything else had been explained before. It is a real circular "spectrum" we see in the sky, though rather faint, because only a part of the light is reflected from the farther side of the rain-drops, and a great deal passes right through, and is lost to us.

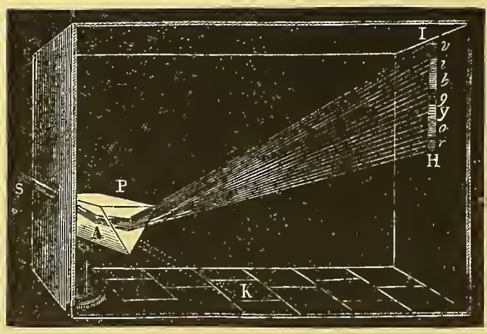


Fig. 5.—THE SPECTRUM.

It will be readily seen from all this that two people never see exactly the same rainbow. Each sees his own, in those drops which reflect and refract the sun's rays to his own eye at the proper angles, as in the illustration on the last page. Any one standing by sees the rainbow in quite other drops of water, according to his own position. So also the size of the rainbow depends upon the distance of the rain-drops in which it is seen. The *angle* the bow subtends to the eye will be the same; but a bow may occasionally be seen in the same street, almost as if in a neighbouring fountain, when it will appear small; while, on the other hand, if the shower is distant it will appear very large.

Beautiful rainbows can be seen whenever a shower of small drops can be looked at in front, with the observer's back to the sun. A watering-pot with a fine rose will make a good one; and so will any fountain that scatters close and fine spray. At the seaside, whenever the sea dashes against the wall of an esplanade to any extent, as at Hastings, fine rainbows can often be seen in the sea spray. Besides the usual outer bow which has been explained, some other secondary bows are possible when the sun is very bright and the rain fine and dense; but they are usually too faint to be perceived. And besides all these usual appearances, some very remarkable and extraordinary ones are sometimes seen, which are worth making the subject of a separate account.

Lunar rainbows are not often seen, because the light is not sufficient unless the moon is bright, and the atmosphere clear between the moon and the spectator. This very seldom happens at the same time as a shower of rain; and when it does, there are seldom people abroad to see it. Still, lunar rainbows are seen occasionally, several being recorded; they are sometimes singularly beautiful, the soft moonlight appearing to add an additional charm to them.

Meantime, there is one more thing to be said about the "spectrum" of the sun's rays which Newton got with his prism. We know now how to see it better than he did. By using a round hole, all the colours more or less overlapped each other, which we can avoid by using a very narrow slit or slice of light. There is no need to darken a room, either. We may stretch across the upper part of a window a band of black paper a foot deep, with a perpendicular slit in the middle several inches long, and one-eighth of an inch wide. Then from the farthest side of the room look at this slit through a glass prism off one of the three-cornered lustres on the mantelpiece or chandelier, turning this simple prism, and looking obliquely through it, till the slit of bright light from the sky is drawn out into the beautiful rainbow band. The farther off we go the longer it is, and we want it as long as possible. Now it will be seen that the "spectrum" is crossed by several black lines. How many are seen will depend on the goodness of the glass from the lustre, and the width of the room ; but there will always be seen at least one very plain line in the yellow part, and another in the violet or blue, while a very heavy or dense prism will show five or six lines. The curious thing is that when we use sun-light for our slit, whether direct, or reflected from the sky or anything else, these black lines are always there ; and as soon as this was discovered, people naturally began to ask what they meant. Out of them, and out of those questions, grew the wonderful science of *Spectrum Analysis* : a science well worthy of a little explanation by itself, and which has revealed a whole universe of wonders to the inquiring mind of man.

Some Physiological Wonders.

AN OSSIFIED MAN.—There was, and probably still is, in the Dublin Museum, the carcase of a man named Clerk, a native of Cork, whose body and limbs gradually ossified, so that he resembled at last a statue of stone, being unable to bend his body or use his joints. A magazine published in 1838 states that he had been a young man famous for strength and agility, and that the first indication of his disease followed close upon a night which he had passed asleep in the open air after a debauch. From that time, by slow degrees, every part of him solidified, his joints becoming rigid, and only his eyes, skin, and intestines retaining their natural condition. His teeth became a single bone, through which a hole was bored for the admission of food. Before he expired sight deserted him, and he was unable to speak.

A SINGULAR WOUND.—On June 18th, 1855, before Sebastopol, Lieutenant French, of the 38th Regiment, received a gun-shot wound, which "penetrated the chest, resulted in a most copious suppuration from the left side, with compression of the left lung, and *removal of the heart to the right side of the chest!*" The result was loss of power to use the right arm, enfeebled health, and ultimately—on December 9th, 1857—death.

SHOT THROUGH THE HEART.—In the Military Hospital at Plymouth, there was until recently preserved, and may still be, the heart of Samuel Evens, a private grenadier in the 2nd Regiment of Foot, who died in that hospital on January 30th, 1809, *sixteen days* after he had been shot through the heart !

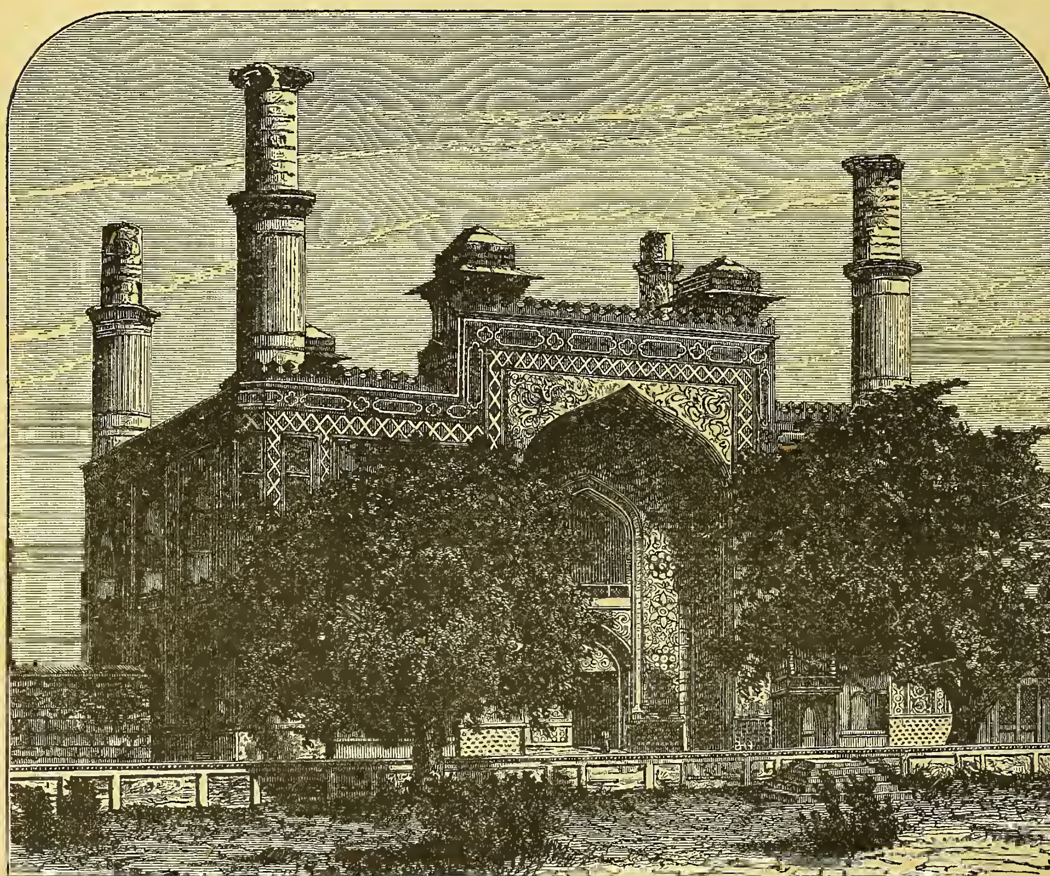
EXTRAORDINARY CURE FOR ASTHMA.—When Colonel Masters, who died in 1799, and fought under the old Duke of Cumberland, met any one suffering from a violent asthma, he used to tell them that he was violently attacked by that disorder, and found a sudden and perfect cure on the battle-field, where a musket-ball passed through his lungs.

TALKING WITHOUT A TONGUE.—The tongue is usually regarded as absolutely essential to speech, and it is so, so far as regards the pronunciation of *t* and *d*. It would appear, however, that with these exceptions, speech is possible without a tongue, as Professor Huxley has given an account of a tongueless man he himself examined who could talk. The man's tongue had been removed as completely as possible by a skilful surgical operation, so that when the mouth was opened only the stump of it could be seen as far back as possible. His conversation was perfectly intelligible ; and he clearly pronounced such words as *think*, *the*, *cow*, and *kill*. Words with an initial or final *d* or *t* sound were too much for him, thus tin became *fin* ; tack, *fack* or *pack* ; tool, *pool* ; dog, *thog* ; dine, *vine* ; dew, *thew* ; cat, *catf* ; mad, *madf* ; and goose, *gooth*. All *t's* and *d's* were converted by him into *f's*, *p's*, *v's*, or *th's*. *Th* was fairly given in all cases ; *s* and *sh*, *l* and *r*, with more or less of a lisp. Initial *g's* and *k's* were good, but final *g's* were all more of less guttural.

VOLUNTARY MOTIONS OF $\frac{1}{1200}$TH OF AN INCH.—At the top of the wind-pipe there are two muscles called the vocal chords, which produce voice. When they are stretched, and air is forced past them from the lungs, they emit sound, the loudness of the sound depending to a great extent upon the force with which the air is expelled from the lungs. The pitch of the note depends upon the tension of the vocal chords. Now these muscular chords in man are only, when at rest, about $\frac{73}{100}$ths of an inch long. When stretched to the greatest extent they are about $\frac{93}{100}$ths, or $\frac{1}{5}$th of an inch longer. From a state of repose to a state of extreme tension, there are a great variety of sounds which a vocalist could emit at pleasure. If we suppose with Carpenter that the natural compass of the voice is twenty-four semitones, and that within each semitone the singer can produce at least ten distinct intervals, then this would mean 240 different states of extension for the vocal chords—*i.e.*, in passing from one interval to another the vocal chords would not be stretched out more than $\frac{1}{1200}$th of an inch. And in distinguished singers the sense of hearing and power of regulating the movements of the vocal chords have been known to be brought to such a state of perfection that it was possible for them to stretch or contract the chords by the $\frac{1}{10000}$th of an inch !

THE MOST WONDERFUL TOMB IN THE WORLD.

THE tomb of the greatest monarch India ever had, Mohammed Akbar, who reigned between 1556 and 1605, is truly a wonderful one. Approached through a grand and lofty archway, with gallery chambers, and vaulted dome, it stands by the ruined village of Secundra in a quadrangle enclosure, at each corner of which a minaret rises. You follow a paved pathway through what was once a beautiful garden overshadowed by graceful trees, in the centre of which, rising to the height of 100 feet, stands the mausoleum, a massive pile of red stone, each side of the base measuring 300 feet, adorned with stone and marble, with rich carvings and inscriptions from the Koran. The area in which the tomb stands covers about forty acres. The tomb itself has five stories, forming a kind of pyramid, surrounded externally by cloisters, galleries, and domes, gradually diminishing as they ascend till it is crowned by a square platform and elaborate lattice or screen-work, both of white marble, in the centre of which is the altar-tomb of the same material, "carved," says Bishop Heber, "with a delicacy and beauty which do full justice to the material and to the graceful forms of Arabic characters which form its chief ornament." The plain and narrow tomb immediately above the ashes of Tamerlane's mighty descendant exists in a small but very lofty vault at the base of the building. It is of white marble, narrow, plain, and without adornment. There are four entrance gateways to the tomb of red granite, one in each of the lofty, battlemented walls, at the four corners of which are four octagonal towers with their minarets. Around the tomb, and for about six miles on the road to Agra, walls, tombs, mosques, minarets, and summer-houses of marble, granite, and other stones exist in a ruinous condition, some of the old tombs



ENTRANCE TO THE TOMB OF AKBAR.

having been converted into dwelling-places, and not far from Akbar's tomb is that of his famous minister Abulfazel. The tomb is approached by four causeways, along which may be still traced the relics of stone pillars placed at intervals amongst trees, which formerly existed along either side of them, with watch-towers, halting-places, and serais with wells for pilgrims. It is traditionally stated that the trees which first shaded the wayfarers were carried away full-grown from the forests and planted along the sides of the causeways. The Prince of Wales when in India visited Akbar's tomb, the grandest men ever reared to perpetuate the memory of a fellow-man. Mr. Bayard Taylor describes it as nobler and greater in conception and embodiment of Saracenic art than the Alcazar or Alhambra. It is not only the ground it covers, and the solid amount of masonry that makes up the vast and stately building: the marvel rather is in the profusion with which the whole has been enriched, down to the smallest detail, with the utmost perfection of oriental art.

TATTOOED MARQUESAN ISLANDER.

TATTOOING.

THE practice of tattooing the skin has probably, at one time or another, been universal throughout the world. We still, however, occasionally see the school-boy disfiguring or adorning his arms and hands by rude tattooings, of which he is sufficiently proud—at least until, having arrived at years of discretion, he sees the folly of his ways. Our sailors, too, are often tattooed with various designs symbolical of their calling. Probably the origin of the habit of tattooing the body arose from the more primitive custom of painting the skin of various colours—a custom which has prevailed amongst all manner of men from the earliest recorded times, even down to the present day. When Cæsar first landed his legions upon the shores of Albion, he found the gallant Britons of his time stained and decorated with the blue juice of the woad. Dr. Prichard tells us that the Red Indians owe their name, not to their copper-coloured skins, but to the practice so common amongst them of painting the face, and sometimes even the whole body, of a brilliant scarlet hue. The great warriors did not, however, confine themselves always to a single tint, but might sometimes be seen with one side of the face ornamented with various-sized circles of vermilion, while the other side was plastered with alternate streaks of red and green. The tribes of the Amazons, too, are distinguished by the quaint and grotesque patterns with which they frequently paint their bodies, either to make them appear more terrible to their enemies, or more pleasing to their friends. Nor is the art of painting the face confined entirely to the savages of either the Old or the New World. High-caste Brahmins may often be seen in India decorated with an occasional streak of red or white paint; and we are all acquainted with the delicate tints imparted to the skin by she-Brahmins nearer home, by a judicious application of pearl-powder and rouge.

From the temporary adornment of painting it was not an unnatural transition to adopt the practice of tattooing, by which means not only was the trouble of painting avoided, but some brilliant and startling effects could be produced, which were attainable in no other way. As America may be regarded as the chief seat of the art of painting, so in the islands of Polynesia does tattooing attain its greatest development, though, in fact, the custom prevails from New Zealand to Japan, and from Malay to the most western islands of the Pacific; while for the word itself we are indebted to the language of the South Sea Islanders.

Though tattooing is mainly resorted to for the purpose of ornamentation, occasionally there is some signification in the operation, as when the Hawaiians tattooed their bodies in token of grief and respect, upon the death of their king. The various designs tattooed upon the body sometimes serve, also, to indicate the rank, family, or exploits of their bearer; in some parts of Africa, for instance, a long scar on the thigh indicates that the possessor of this coveted decoration has done bravely in war. Sometimes, too, the tribe or nation to which a negro belongs may be indicated by the design tattooed upon his face or body, such as "a pair of long cuts down both cheeks, or a row of raised pimples down his forehead to the tip of his nose." Amongst some tribes of Australians it is usual to tattoo new designs upon the skin upon any important occasion in the life of the individual; and sometimes tattooing appears amongst certain people to be analogous to the rite of armament of the newly-made knight during the Middle Ages; while it is curious to observe that the Tchuktchis of Eastern Siberia, though completely clothed, are yet accustomed to tattoo themselves deeply, to show their prowess in hunting, in fishing, and in war. In New Zealand a Maori woman would be regarded with scorn and disgust who had not at least her mouth tattooed, and her people would taunt her with the disgrace of having "red lips," so greatly do ideas of beauty differ. Upon whom the duty of performing the unpleasant operation devolves it is not always easy to determine: sometimes it is performed by the old women of the tribe, but when the tattooing possesses any religious or symbolical meaning, as it does amongst the Alforians, or Alfourous, who inhabit the interior of New Guinea, it is carried out either by a priest or by a great chief of the tribe to which the acolyte belongs.

The most common form of tattooing is that produced by making small punctures in the skin, and rubbing into them some colouring-matter, generally the coloured juice of some native plant. But in Polynesia the operation is by no means limited to simple punctures. When, for instance, a youthful brave of Fiji, of New Zealand, or of the Marquesas is to be tattooed, a drawing of the design which it is proposed to produce is made either upon a leaf or upon a fragment of thin and pliant bark. This drawing is applied to the skin, and the lines are then followed with a sharp bone knife, made for the purpose, which cuts deeply into the flesh, leaving upon the part thus operated upon an exact reproduction of the design intended. Into the wounds produced by this painful process is introduced not only colouring-matter of various kinds, but also vegetable irritants, particularly wood-ashes, which retard the healing process, and frequently result in the production of hard ridges, raised considerably above the regular level of the skin. The Maori warriors are particularly addicted to this most painful practice, and are often to be seen covered with complicated patterns in relief, not dissimilar to those designs which they are accustomed to carve upon their paddles, clubs, or canoes.

Sometimes tattooing would seem to take the place of clothing; not only taking away all appearance of nakedness, but often being highly ornamental. The Polynesians, for instance, are frequently covered with arabesques, circles, and other designs, which produce a most graceful effect; while in Japan there is no end to the extraordinary representations which are to be met with upon some of the votaries of the fashion of tattooing. At Yokohama the house-servants may often be seen covered by a many-coloured tattooed design, resembling a quaint and complicated damask pattern, or such pictorial designs as are shown in the accompanying plate; and so completely is the body covered by this extraordinary vestment, that but the smallest scrap of clothing is sufficient to take away all appearance of indelicacy.

Popular as is the practice of tattooing throughout the whole of the islands of the Pacific, the extent to which it is carried by different tribes varies considerably. The painful operations undergone by many of the New Zealanders have been described by some travellers as resembling the crimping of fish more than anything else; and sometimes these operations occupy months, and even years, in their progress to perfection; while it is evident that the profuse decorations of the Japanese must occupy a very considerable period for their production, and must often entail the most acute suffering during that time. Amongst others, the Pelew Islanders were observed by Miklucho-Maclay, during his voyage in Micronesia in 1876, to be tattooed to a less degree than their neighbours, the Japanese and other Polynesians; but this was accounted for, not by their greater indifference to personal adornment, but by the fact that they were unable to support the physical shock produced by tattooing upon a large scale. So great, indeed, is the shock to the nervous system, that the health generally suffers under the operation, and death itself has been known to result from the laudable desire of the unfortunate islanders to possess as highly-decorated a cuticle as their neighbours.

TATTOOED JAPANESE SERVANT.

Amongst the American Indians, who, as already observed, are distinguished by their love of gaudy and grotesque painting, the custom of tattooing, though known, is but seldom practised, and is sometimes even regarded as a disgraceful and ignominious kind of mutilation. But in Africa it is almost as common as in the islands of the Pacific, though possessing none of the complicated and æsthetic qualities of the Polynesian tattooing. Generally, indeed, the Africans confine themselves to rough incisions, which produce coarse raised scars, and to rows of small pimples upon the cheeks and temples, and sometimes upon other parts of the body, such as are respectively seen amongst the Bantetochs of Loango, on the western coast, and the Barabras and the Bejas of the Nile. The Bongos are, however, sometimes completely covered with tattooing, which consists, not in a series of punctures, but in groups of long incisions, the healing of which is retarded by the use of irritant substances until strongly-raised ridges are produced. The natives of Ouwinuza, on the famous Lake Tanganyka, indulge in a more tasteful form of tattooing, covering the body with spirals, circles, straight lines, and other simple figures ; while at Kasangalohowa, upon the same lake, the natives, according to Cameron, wear a line of tattooing down the middle of the forehead, and two similar rays upon the temples, which are sometimes continued to the chin, and which he regards as distinctive of the tribe. West of Lake Tanganyka the same traveller describes both sexes as being tattooed in an irregular manner, the frightful scars left by the deep gashes inflicted during the process being often of the most repulsive appearance.

A form of tattooing existing amongst the negroes of the African coast has been described by Dr. Tavano. A long thick steel needle is introduced obliquely under the skin, to a depth varying with the size of tattooing desired. By means of this needle the skin is drawn up as by a lever, and thus gathered into a kind of ball, or knob, which, when healed, forms a more or less regular sphere. These strange ornaments are generally placed below the nose and upon the lobes of the ears, and are affected as a rule only by the men. The operation, which must be an extremely painful one, is performed during extreme youth, possibly because no one who had attained to riper years would be willing to undergo the necessary amount of torture.

Even higher in the scale of civilisation, tattooing still holds a place; and not only Hindoos, but also Arab women may yet be seen endeavouring to add to their personal charms by slight touches of indigo beneath the skin of their faces, arms, and ankles. Nor must we forget that our own fair daughters still have their ears pierced with a view to their own personal adornment ; and though we may stigmatise the more painful and elaborate tattooing of the Polynesians as savage and barbarous in the extreme, we should still remember that we have not ourselves quite abandoned those habits of mutilation, for which doubtless we are indebted to our early, and almost equally barbarous progenitors.

ICEBERGS.

ICE-MOUNTAINS or icebergs floating in the ocean are wondrous sights. A comparatively new one in the Antarctic Ocean appears like a flat expanse of snow bounded all round by perpendicular ice-cliffs, as high as 300 feet from the surface of the water. As they are met with in the comparatively warm waters of the North Atlantic after floating from the shores of Greenland, Spitzbergen and other places, they present all kinds of fantastic shapes which have been produced by the melting influence of sunshine, warm winds, and warm water. Their upper parts present imaginary likenesses to crags, cliffs, and castles ; picturesque cascades flow down them into the sea, while the action of the ice pinnacles, &c., on the sunlight produces all the colours of the spectrum in wild profusion.

They are, however, things of danger as well as of beauty. On the 7th of November, 1879, one of the Guion steamers, the *Arizona*, struck on an iceberg at ten o' clock at night when 300 miles from St. John's. The sea was calm, and it was not at all dark, but, strange to say, no one saw the berg until the ship was on it. She was going at the rate of 15 knots when she struck head on, recoiled, and struck again in the same place, smashing in about 15 feet of her bows. The fear and confusion of the passengers and crew may be imagined. The fear was not misplaced, as there was imminent danger that some ice-masses would topple over and crush the ship and all its live cargo. The engines were quickly reversed, and the *Arizona* managed to get off with only a few tons of ice on the deck. The ship was put back to St. John's. This iceberg was estimated at from 400 to 500 feet in diameter, with three pinnacles 60 or 70 feet above the water. Not long after, the *Gudren*, a Norwegian bark bound to Quebec, was wrecked by ice.

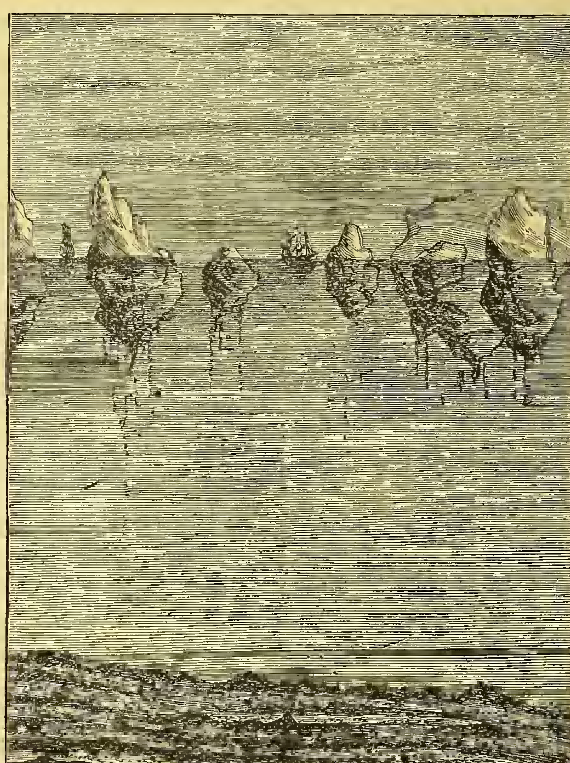
During the year 1882, the North Atlantic was made most unusually perilous by the presence of icebergs. The *Western Belle*, from Greenock, struck an iceberg off Newfoundland on May 1, and sank instantly with all her crew, and the brigantine *Rescue* was completely crushed near Belle Isle. One ship passed bergs daily from the 7th to 17th of May in latitude 43° and longitude 37°, some of immense size, with arctic animals living and dead on them. Fortunately these bergs cannot proceed beyond a certain limit on their southward course without disappearing, and they are seldom, if ever, observed beyond the 40th parallel of latitude.

In the Southern seas great fleets of icebergs have been seen as far north as the latitudes of Cape Horn and the Cape of Good Hope. When H.M.S. *Galatea*, captain the Duke of Edinburgh, was on her way home from her cruise round the world, icebergs were met with before rounding Cape Horn. Between the 50th and 60th parallels of S. latitude bergs were constantly coming in sight. In Milner and Brierley's account of the voyage they say, "Our anxiety was great, considering the almost total destruction of our ship and 540 lives that a collision with one of these dangers must have brought about, as the ship was travelling at a great speed before strong westerly winds. We did not relax in our vigilance, however, but with men placed to look out, and testing the temperature of the water every hour, did all in our power to secure the safety of the ship."

As the *Challenger* proceeded towards the Antarctic circle all the icebergs seen were numbered each day, and their positions noted down. But when they came to have forty in sight at once, this plan was abandoned, and subsequently they had as many as a hundred in sight on several occasions. Coleridge's lines in "The Ancient Mariner" forcibly describe their position:—

> And now there came both mist and snow,
>   And it grew wondrous cold :
> And ice, mast high, came floating by,
>   As green as emerald.
> *   *   *   *   *
> The ice was here, the ice was there,
>   The ice was all around :
> It cracked and growled, and roared and howled,
>   Like noises in a swound !

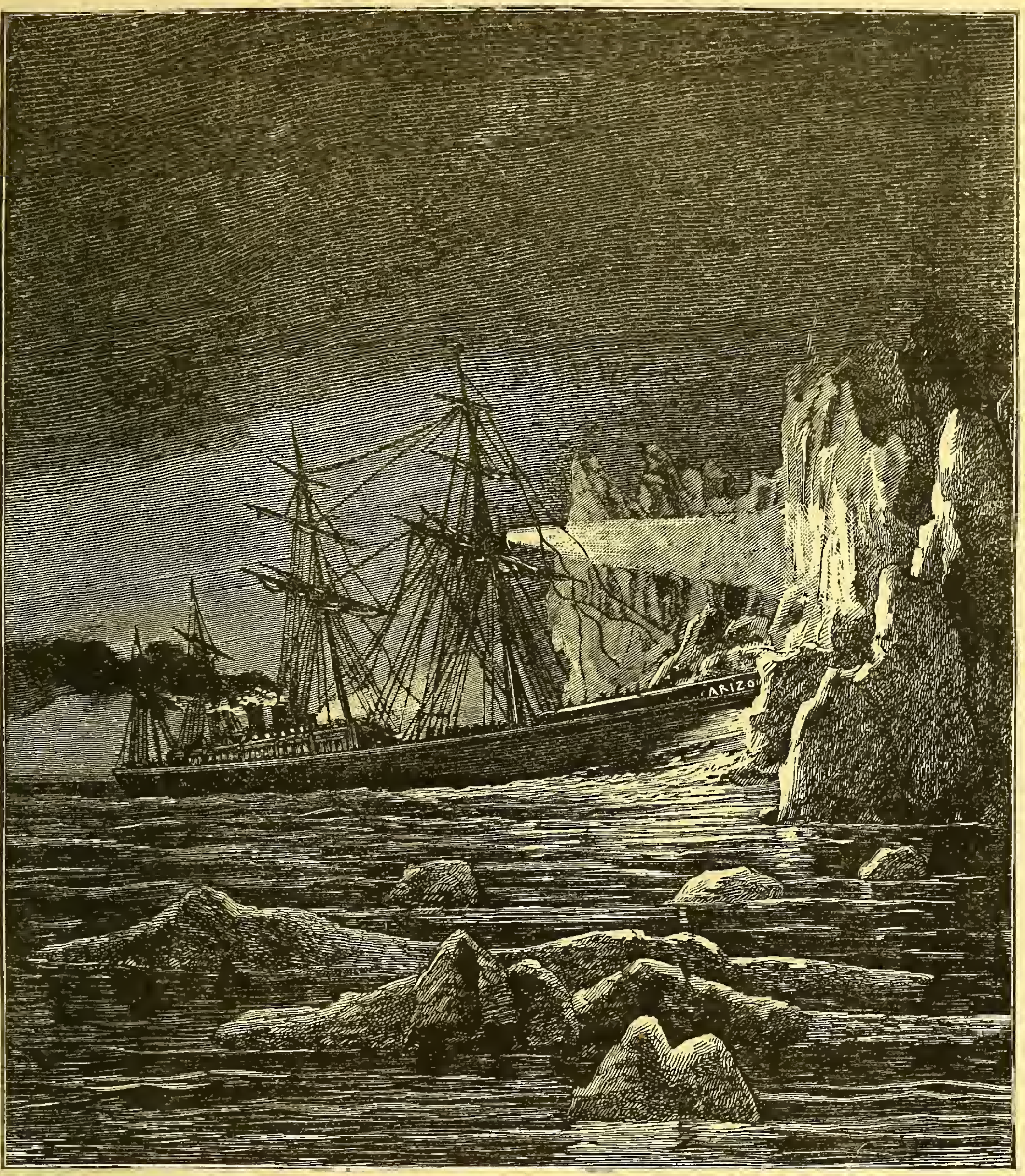
The *Challenger* had many narrow escapes, the jibboom being once forced against the side of a berg and broken. Accordingly to Mosely, the sea at the foot of one of these bergs usually looks of a dark indigo colour; and the colouring of the crevasses, caves, and hollows in the bergs themselves is of the deepest and purest possible azure blue.



ICEBERGS.

Regarding the birth of icebergs, they would appear for the most part to be the product of glacier motion. A glacier, say on the coast of Greenland, like the Humboldt glacier, of vast extent and thickness, slowly pushes its wide river of ice into the sea. The sea end of the glacier extending some distance under the water, there is an enormous strain upon it because of the ice's tendency to float. When the strain has reached a certain point, large masses of the ice are broken off, and then surge upwards and float away as icebergs. Kane, the Arctic explorer, observes, "Regarded upon a large scale, I am satisfied that the iceberg is not disengaged by *débâcle*, as I once supposed. So far from falling into the sea, broken by its weight from the parent-glacier, it rises from the sea. The idea of icebergs being discharged, so universal among systematic writers and so recently admitted by myself, seems to me now at variance with the regulated and progressive actions of nature. Developed by such a process, the thousands of bergs which throng these seas should keep the air and water in perpetual commotion."

Only a small part in comparison of the total bulk of an iceberg can float above the water-line, so that the proportions of an iceberg above and below water will be much as represented in the figure. They have been seen as much as 600 feet in height above the water-line, but usually they are not more than 200 or 300 feet high. Stranded icebergs have been measured. Lieutenant Parry and Captain Ross found one grounded in Baffin's Bay, 20 miles from land and in 61 fathoms of water. It was 4169



THE STEAMSHIP "ARIZONA" ENCOUNTERING AN ICEBERG.

yards long, 3,869 yards broad, and 51 yards high, and its weight was estimated at 1,292,397,673 tons. Dr. Hayes measured one farther north off the harbour of Tessi Usak, aground in water nearly half a mile in depth. It contained 27,000,000,000 cubic feet of ice, and must have weighed not less than 2,000,000,000 tons. When such an iceberg is stranded in lands in the temperate zone, its cooling influence is felt for miles, and temporary desolation is produced all round it.

H

THE PRINCESS CARABOO.

AMONGST the less well-known instances of extraordinary imposture, not the least strange and amusing is that of a supposed Eastern princess, carried away from her native land by pirates, who was said to have been discovered some miles from land in the Bristol Channel, swimming, in apparently the last stage of exhaustion, and brought to shore. She spoke a language no one understood, which she wrote in a clear, delicate, but singular handwriting; and she intimated by signs that she had recently experienced ill-treatment at the hands of some persons from whom she had, at the risk of death by drowning, contrived to escape. She was without clothes when taken up, and wore round her neck something supposed to be a charm. Her case excited the strongest interest in Bristol, and found its way into the newspapers, in consequence of which a then well-known physician residing at Bath interested himself in her behalf, and brought her to that city, where he was well known.

It was then noted as astounding that the language she spoke was a strange one, even to the most accomplished linguists. Her letters were sent to both the Universities to be deciphered, but in vain, and this fact becoming very widely known, created a still greater sensation.

Her name was supposed to be Caraboo, and the country she came from was supposed to be Eastern, and named Javasu; it was also believed that she was of royal rank; but as these ideas were derived only from her signs, there was not much certainty about them. The curiosity she awakened led ultimately to her exposure, and it soon afterwards oozed out that her birthplace was Devonshire, and her career a very remarkable one.

She was born at a little place called Witheridge in the year 1792, her name was Mary Baker, and she was employed by her mother when very young at spinning. She was, however, of a wild, roving, reckless disposition, and fond of boyish games and sports, particularly of swimming, in which she excelled most of her age. Spinning was irksome, and she preferred the labour of weeding in the cornfields. Becoming a source of intense anxiety and trouble to her mother, she was sent to service in Exeter, where she remained but a short time. To gratify her love of freedom and adventure, she deliberately adopted the degrading trade and crafty devices of a wandering beggar, wearing her oldest clothes, neglecting her person, and doing all she could to increase the misery of her appearance and awaken pity in the charitable. She slept by the roadside, under sheds, hedges, and hayricks, and in this way arrived in Bristol, where she made application to the Stranger's Friend Society for assistance. The inquiries made by the officers of the society so frightened her, that she suddenly left that city to make her way to London.

When nearing the great metropolis she was taken ill and conveyed by a kindly waggoner to St. Giles's Hospital, to which she was admitted delirious with fever. There, her seeming innocence, shyness, youth, and engaging manners awakened considerable interest, and the chaplain of the institution was deeply touched by her friendless and forlorn condition. On her recovery he procured her a situation as maid-servant in a strictly respectable family, where she was kindly treated and remained three years. At the expiration of that time she was so heartily weary of a life of tame commonplace respectability, that she gave notice and went away.

Disguising herself as a man, she soon after applied for and obtained another situation as footman in a gentleman's family, and was actually taken down into Devonshire, where she resided for some time within a stone's throw of her mother and father without being recognised by them. About three years after, while still in Devonshire, the supposed footman was sent out one winter evening to deliver a letter. On her return she lost her way in a snow-storm, and, overcome by the intense cold, sank down exhausted, where she was found by those sent in search of her (him) on the following morning. When she was carried home, on her clothes being removed her sex was discovered, and she was discharged.

She was afterwards in the service of some respectable families in Ayrshire, in the west of Scotland, where she also figured somewhat prominently under the name of Mrs. Mackrinkan.

Then came the crowning piece of imposture. Soon after a storm in the Bristol Channel a young woman was picked up in the sea, where she was swimming, apparently, as we have said, in the last stage of exhaustion. She was very pretty, had "a sweet smile," and spoke in an unknown tongue. Being brought ashore and wrapped in a blanket, she was taken in by a charitable person named Fay. She strove to express by signs her having been taken prisoner by violence and carried away on board a ship, from which, nearing some strange country, and being rendered desperate by fear, she escaped by leaping into the sea, and had been swimming for some hours, when she was taken up and brought to Bristol. Her story, finding its way into the local papers, attracted the attention of Dr. Wilkinson, who took charge of her and brought her to Bath. Here her case soon attracted general attention, and her story travelling, brought many persons to Bath who were anxious to investigate the case. All sorts of facts were brought forward to support the story she told in signs; and the ship in which she had been prisoner was soon identified as that of a desperate pirate who had been seen in different quarters by various nautical observers at different times. Everything she did was made public. It was said that she wore as a charm something "not unlike the Chinese *suon-puon*," that the food she preferred was fish; that she had a strong dislike to the society of men; that she worshipped the sun at its rising and setting; that she was an accomplished wielder of sword and dagger; that she had a scar upon her back.

Suddenly she disappeared, and the next thing heard of her was that she had been seen begging on a country road, and that she had asked a man who passed her on a cart, *in English*, to give her "a lift."

She afterwards made a full confession.

There is extant, in various old magazines and ballad collections, a song which was popular then, and was dedicated to "Dr. W—n of Bath." We quote but one of its fourteen verses :—

" One morning, when gorged to the full,
She stole from her cage like a squirrel,
Glumdalclitch ne'er griev'd for her gull
Like the gull of all gulls, Mrs. W—rr—ll.
'Hue and cry—search the whole of the nation;
She's stolen by some Macratoo!
I've lost my outlandish Circassian—
Oh, where, and oh, where's Caraboo?"

VORTICES.

THERE is no such thing as rest in the universe. Everything is in motion, and the whirling or rotating motion appears to be the favourite one in Nature. All the planets as they pass through space have a whirling motion : they roll round on their axes. The earth also rotates, and on its surface there are rotating fluids—cyclones and whirlpools—and the very atoms of which the world is formed are supposed to be etherial vortices.

The gigantic vortices on the earth's surface, viz., the whirlpool and the cyclone, are essentially of the same nature as the eddy of dust one sometimes sees at a street corner, or as the little hollow vortices seen in the wake of a rudder. They are masses of air or water, with a top-like spinning motion, and they are the simplest kind of vortex. The only difference between a tiny dust whirlwind and a cyclone, or between a small whirlpool and the Maelstrom, is one of strength, the cyclone and the Maelstrom dashing about large objects with the same ease that the tiny whirlwind and whirlpool move dust-specks about.

What is known as a "vortex-ring" is of a more complex nature than either a simple whirlpool or whirlwind. Fortunately, it can be made with ease either in a liquid, like water, or in a gaseous mixture, like the air we breathe. Vortex-rings may be made in water, for example, in the following simple way. We require a glass of water, some ink or milk, and a needle or pen. Let us suppose we are writing: then we simply dip the pen-point, charged with ink, below the surface of the water; when instantly there is formed a slowly descending ink ring, which before long grows into two others, and these, in their turn, multiply, and so on until quite a network of rings is seen to be travelling towards the bottom (Fig. 1). If we are using milk instead of ink, then it is necessary to dip a needle into the milk, so that when withdrawn there may be a drop formed at the end of it. This drop is now gently delivered to the surface of the water in the glass. When the globule of milk comes into contact with the water, it descends, and, after the manner of the ink, soon forms a beautiful system of rings. The rings here are so small that one sees no motion except that which carries them to the bottom of the vessel.

To make vortex-rings in air is a trifle more difficult. Perhaps the most simple plan is the following.

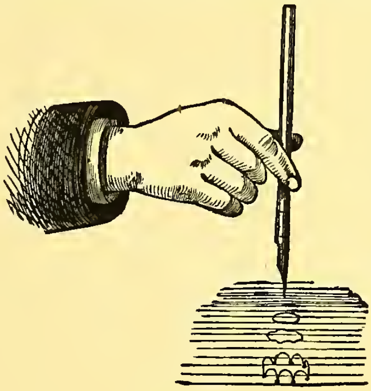


Fig. 1.

Take a match-box, and make a small round hole in one end (Fig. 2). Now slide out the inner portion of it, and put in a little very dry tobacco. Ignite the tobacco, by dropping a lighted match on to it, and then close the box. By giving the end of the box opposite the hole a smart tap with one finger, tiny smoke-rings will be made to issue from the orifice. Of course it is necessary to have the tobacco within the box burning to furnish smoke

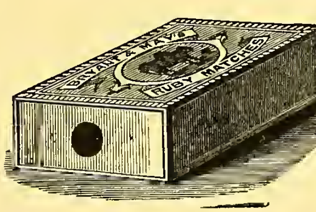


Fig. 2.

for the rings, and the box must be so held with regard to the light that the issuing rings can be seen.

These smoke-rings are also often made by smokers, some of whom have the knack of puckering up the mouth when full of smoke, and sending forth rings at pleasure. They may sometimes be seen issuing from the chimney of a locomotive, and they are regularly produced by the chemist when making phosphoretted hydrogen. In the latter case, the gas coming from a retort is led under the water; bubbles of it then ascend, and breaking as they reach the surface of the water, give rise to beautiful white rings of phosphoric oxide.

Vortex-rings of smoke may be made on a large scale in the same way as with the match-box, by the following simple means. Procure a tea-chest, from which, of course, one side will have been taken to remove the tea ; or a strong band-box will do as well. A round hole, three or more inches in diameter, has to be cut or sawn by the carpenter out of the side directly opposite to the one which has been removed. A sheet of canvas must next be nailed over the open end of the tea-chest. If the canvas be now struck, a "vortex-ring" issues from the circular hole, and may be made to travel many yards off. This ring is, however, invisible as yet, for it consists only of air. To make the ring visible, the box must be filled with smoke, which may be done by holding inside some smoking brown paper. When the box is charged with smoke a beautiful white ring issues every time the canvas is struck.

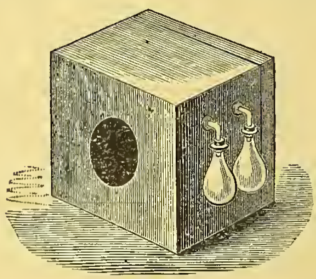


Fig. 3.

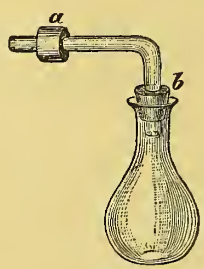


Fig. 4.

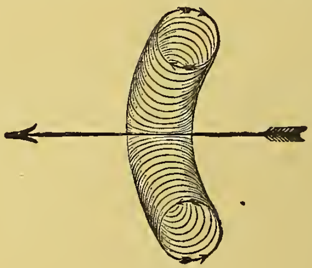


Fig. 5.

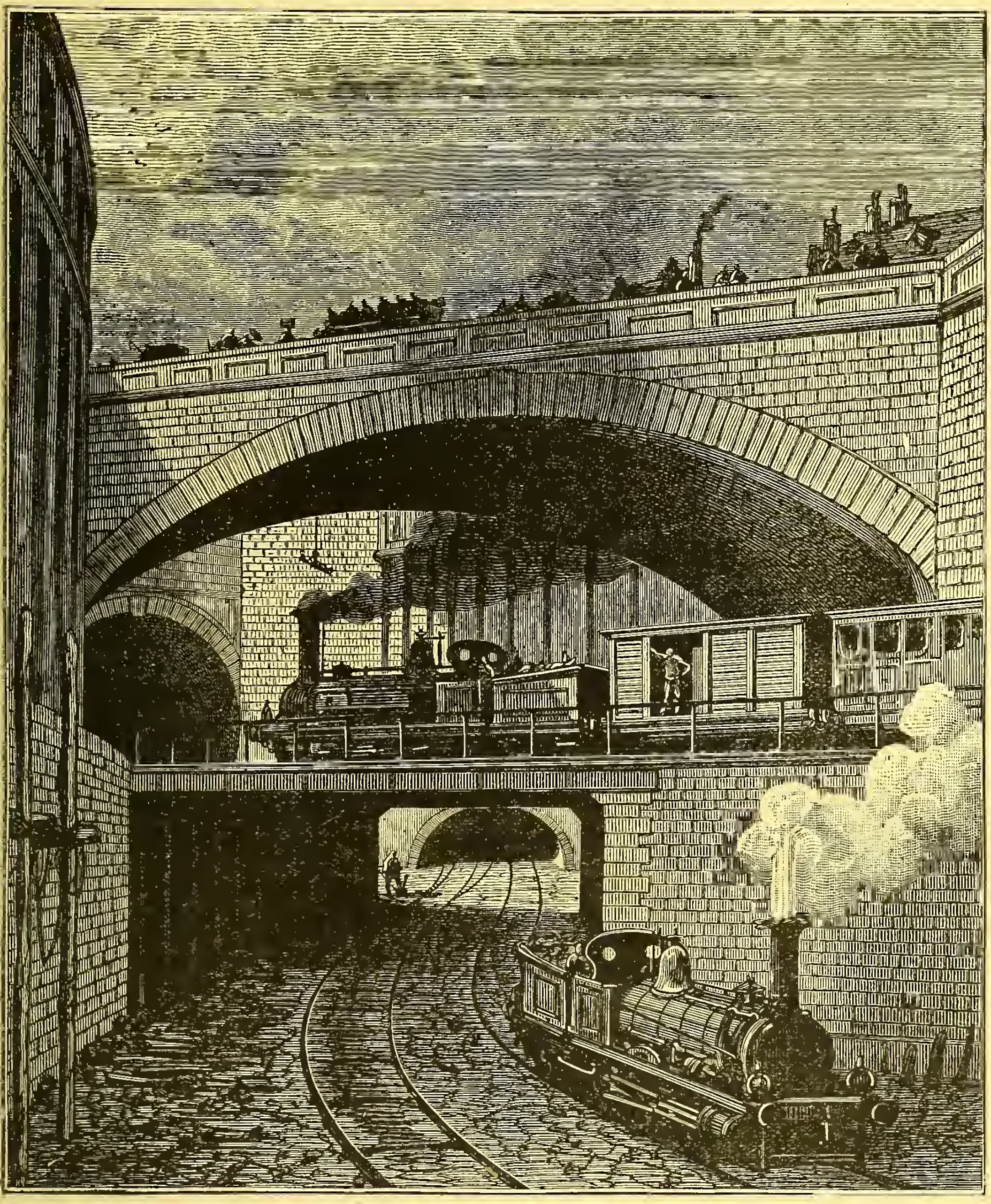
The best way of filling the box with smoke—or rather, with visible particles to make the rings visible —is, however, to have a couple of flasks attached to the box (Fig. 3). The way in which this is managed is very simple. A bent piece of tubing passes through two corks, *a* and *b;* one of the corks, *a*, is fitted into the side of the box, and the other, *b*, fits into the flask. There is thus a communication between the contents of the flask and the inside of the box. Two flasks joined to the box in this way, one containing strong solution of ammonia and the other hydrochloric acid, are now gently heated with Bunsen burners or spirit-lamps, and the gases arising from the solutions enter the box, and combine to form a dense white "smoke," consisting of fine particles of sal-ammoniac.

By watching the large rings which issue from the vortex-box, it will now be seen that they have two motions: a motion of translation and the "vortical" motion. In this vortical motion the inner portions of the ring appear to be moving in the direction the ring is bodily going, but the outer portions appear to have a motion contrary to this. Thus, if Fig. 5 represent a section of one of these rings, the big arrow showing the direction it is moving in, then the smaller arrows will show the nature of the vortical motion of the ring. Such a ring is really a string of whirlwinds put end to end in circular fashion, and all moving together in the same direction.

We must remember that the smoke has nothing to do with the vortex. That is in the air, and the smoke only makes it visible, as the dust-motes do a sunbeam. Now this whirling ring of air will travel unbroken all across quite a large room, and even blow out a candle there. How wonderful it is that free air, unconfined—the most free and "loose" medium we generally think of—should thus keep separate, tied together, as it were, by this curious circular vortex motion! It is so much so that if two separate rings are sent against each other, they recoil and tremble much as two floating india-rubber rings would do; and if we try to cut one with a knife, we cannot do it—it recoils, and will *not* be cut, though it is gradually dispersed by the friction of the air itself. We shall see in another article how these facts have helped our greatest philosophers to the latest and most probable conclusions now generally held concerning the mystery of matter.

THE UNDER-GROUND RAILWAYS OF LONDON.

In the early days of our great railway system the inhabitants of the large towns were as anxious to keep railway stations away from their houses as they are now desirous of having them at their very doors. This objection, and the legal and other difficulties which prevented, in those times, the acquisition, on reasonable terms, of house property in London (belonging in many cases to a large number of owners) kept the termini of the great railways at a respectable distance from the town itself, as it then was. But when the incredible and totally unexpected results of the railway system and the increasing congestion of the



DOUBLE TUNNEL NEAR FARRINGDON STREET STATION, METROPOLITAN RAILWAY.

traffic were fully realised, the absolute necessity of uniting the various stations by a line which should bring them into communication with one another, and with all parts of the metropolis, became manifest. The first section of under-ground railway, from Paddington to Farringdon Street, having been opened on the 10th of January, 1863, numerous schemes were immediately proposed; a Parliamentary Committee of both Houses was appointed, and the "Inner Circle" plan of Mr. Fowler, C.E., was adopted, together with an "Outer Circle" scheme.

The engineering difficulties which, at almost every yard, surrounded the enterprise, were of course varied and enormous; and to form a slight idea of these one has only to dwell for a few minutes on the nature and multiplicity of the under-ground communications which already existed in London, complicated as they were by branches at every street-corner, and ramifications in every direction. Telegraph-wires laid in iron pipes ; sewers and drains of all sizes, from the four-inch pipe to the brick sewer six feet high ; "ventilating-shafts," rising straight from the crowns of the sewers to gratings in the roads ; "manholes," or "side entrances," springing obliquely from their walls and ending in the pavements ; water-pipes of every diameter from one inch to three feet ; gas-pipes as large or larger, and sometimes as many as six in one street ; and last, but not least—at any rate in number—the pipes which connect every house with the sewer, the water-supply, and the gas-main; crossing and re-crossing one another everywhere. Among, above, and under all these, a communication far larger than any of them, and less susceptible than any of them of deviation, either upwards or sideways, from its appointed course, had to be driven with unheard-of care and precautions. Alterations and diversions innumerable had of course to be made ; but the regular flow of the water, the sewage, the gas, and the electric currents had still, even during the alterations, to be provided for. Here an unexpected patch of unsound soil, there a superannuated sewer, would cause subsidences which threatened the lives of the workmen, the stability of the unfinished work, or the safety of the houses, below which the new tunnel was being driven as if by some mighty burrowing animal. And when all is complete, the former communications re-established, or very likely re-arranged on a far better and simpler plan; the new houses built up again, the stations or platforms open, and the trains, thronged with passengers, rapidly following one another along the newly-laid metals; how little record is left of the difficulties of which we have endeavoured to convey some faint idea!

Above-ground there seems to be no diminution of the ceaseless, and apparently endless flow of wheeled and pedestrian traffic. It is, however, impossible, in view of the enormous growth of London, year by year, to say what the state of its streets might now have been were the metropolis still unprovided with underground railways. During the year ending December 31, 1881, the number of passengers conveyed by the two companies which carry the bulk of the under-ground traffic, viz. the "Metropolitan" and "Metropolitan District" Railway Companies, was more than 100,500,000! Ten years ago this total was only 63,500,000 ; the increase in that time being more than one-third, and the average daily number of passengers carried over the system during the year 1881 being 275,400.

For conveying this enormous amount of traffic, the two companies possess the apparently small stock of 92 engines and 458 passenger carriages of various classes, while they maintain 28 miles of double and 2 miles of single line, making a total of 58 miles of railway worked by the two companies, while the portion known as the "Inner Circle" is about 12 miles in length. Over these lines, however, other companies run their engines and carriages ; and in addition to the under-ground lines maintained by the two companies, the London, Chatham and Dover system is connected with the Metropolitan Railway by a subterranean line from Ludgate Hill to Aldersgate Street ; and the north and north-west districts of London by a similar line from Baker Street to the Swiss Cottage, continued above-ground from the Finchley Road to Willesden and Harrow; while the "East London" line, starting from the Great Eastern Terminus at Liverpool Street, plunges through the old Thames Tunnel, conferring on this remarkable engineering work, so long known as a mere curiosity, a new life of utility and interest. Then, emerging gradually from its subaqueous passage, this line delivers its passengers at stations in South London, ending in connections with the London, Brighton and South Coast and other southern systems. This railway, and a subway at Tower Hill, are the only means of crossing the river (except, of course, by water) which exist below London Bridge.

It ought to be added that, from various parts of the under-ground lines already alluded to, similar branches and loop-lines form connections with the Great Northern, the Midland, and the Great Western main lines ; with the districts of Bayswater, Notting Hill, Kensington, Fulham, Hammersmith, and Pimlico, and, *viâ* Clapham Junction, with the whole of the South Western, South Eastern, London, Chatham and Dover, and London, Brighton and South Coast lines.

The enormous demands of the traffic on the most frequented parts of the "Inner Circle" may be estimated from the facts, that from Moorgate Street Station, on the "Metropolitan" line, trains run every four minutes from 8 a.m. to 8 p.m.; and from the City terminus of the "Metropolitan District" line every three minutes during the same part of the day. It appears from the reports of the two companies that the average cost per mile, including working, stock, and allowing for the purchase and re-sale of land, has been, in the case of the first-named line, £498,322 per mile, and in that of the second, £421,360.

The extent and advantages of the under-ground railways of London having been thus indicated, it may be interesting to note some of the principal features and peculiarities of construction which occur in the course of the "Inner Circle" route. The portion constructed and worked by the District Company commences at the "Mansion House

Station," which is its City terminus, and thence proceeds to Blackfriars Station, where passengers may frequently hear the rumbling overhead of London, Chatham and Dover trains, which have just crossed the river, and are preparing for their under-ground dive to Snow Hill and Aldersgate Street. At this point arrangements had to be made for a large subway along the Embankment, in which numerous pipes of all kinds were laid; for a tram-road for landing coals from the river; for the low-level main sewer which intercepts all the old sewers formerly discharging into the Thames; and last, not least, for the well-known "Fleet Ditch," a veritable river which, at several points in the Inner Circle Railway, formed one of the chief difficulties of the work, and had to be first temporarily and then permanently diverted by an iron tube seven feet in diameter.

Between "Blackfriars" and the "Temple" Stations the line (here, as in other parts, covered in by a system of girders and flat brick arches) passes over numerous sewers, which discharge into the low-level intercepting sewers lying on the left between the railway and the river. All these tributary sewers had to be, as it were, flattened, or rather, reconstructed with flat tops, so as to allow the rails to be laid at a proper level. Above, of course, are the Embankment and its gardens, and within the precincts of the Temple the train passes over a substratum of six inches of tan, in order that its passage may disturb as little as possible the abstruse legal studies of the tenants of the adjoining chambers. Thence, passing under one of the arches of Waterloo Bridge, where, before the Embankment was constructed, the muddy foreshore of the river lay, the line proceeds to Charing Cross and Westminster Stations, the latter having a subway communicating direct with the Houses of Parliament. Taking a sharp turn to the right, the line reaches the St. James's Park Station, near Queen Anne's Gate. Numerous difficulties, of a different class from those hitherto met with, were here encountered, owing to the nature of the soil and the propinquity of the foundations of Westminster Abbey and St. Margaret's Church, while numbers of fossil remains were brought to light by the excavations.

At Victoria Station another subway gives access to the West-end termini of the London, Brighton and South Coast and the London, Chatham and Dover lines. The drainage of the whole railway has been effected by a barrel-drain laid under its centre; and here, and at the two next stations, are pumping-engines for relieving this drain of its contents. At the next station, Sloane Square, a sewer, in the form of a huge square iron conduit, passes over, instead of under, the railway. From the spacious station at South Kensington, which is next reached, the line, though below the level, is scarcely to be called under-ground, inasmuch as it is open almost the whole way on to Kensington, Shepherd's Bush, Fulham, Hammersmith, Clapham Junction, and Richmond.

Between Edgeware Road Station and King's Cross the Metropolitan line is entirely tunnelled under the roadway; and piercing it and the front courts of several of the houses on either side are numerous ventilating-shafts and gratings, without which the transit would be almost insupportable. As it is, although the engines are ingeniously constructed so as to condense their waste steam in special tanks, and although a particular kind of fuel is used, so as to minimise the contamination of the air, yet the consumption of oxygen and the evolution of carbonic acid gas, flavoured with a perceptible admixture of sulphurous compounds, render the atmosphere far from pleasant at this portion of the line, and indeed produce, in a hot summer, a notable decrease in the traffic.

The line now proceeds directly Citywards, and at the next station, Baker Street, is a junction enabling the traveller to reach, in a very few minutes, St. John's Wood and the Swiss Cottage Stations, while further stations at Finchley Road (within ten minutes' walk of Hampstead) and at Edgeware Road are found on the way to Willesden and Harrow. Portland Road and Gower Street are, like Baker Street, lighted by oblique shafts ingeniously and pleasantly lined with white glazed tiles, and at Portland Road special provision for ventilation is made by means of capacious openings into the roadway above. Perhaps no under-ground line is so much needed as one which, starting from Charing Cross, should join the Metropolitan Railway at, or near, Gower Street Station.

Some of the most interesting works on the line are to be found near King's Cross. They were necessitated by the problem of effecting, with the terminus of the Great Northern main line at King's Cross, and that of the Midland main line at St. Pancras (a short distance farther west) junctions which should enable trains leaving or going to the City, and travelling along the under-ground railway, to reach the two main lines referred to, which are of course to the north of the under-ground railway, and considerably above it in level. This, too, was to be done without any crossing of the latter line on the level. The problem has been solved by making the branch "connecting" lines dive deep into the earth *below* the level of the under-ground line, and then, crossing obliquely under the same by sharp curves and steep inclines, re-ascend till they reach the level of, and are connected with the lines of the two great railways, stretching away to the northernmost regions of the kingdom. A reference to the illustration will make this more clear. In the fore-ground, at the lowest level, is an engine just coming from the main lines referred to and proceeding on its way eastward. Above it is a train going westward on the Metropolitan under-ground line, and above that level again is the roadway.

The section of the line near Farringdon Street Station crosses three times the Fleet Ditch before referred to, and in each case special arrangements were necessarily made for its waters, which had to be conveyed above the line of rails. At the station itself this is done by means of a large wrought-iron tube, or rather aqueduct; and on two or three different occasions during the construction of the line the "Fleet" burst its bounds, and caused, of course, much trouble and delay. At this station, too, is a goods depôt of the Great Northern Railway; and, farther on, the line passes under the Meat Market constructed on the site of old Smithfield Market, and connected by winding cart-roads and sidings with the lines of rail.

From Aldersgate Street Station, where there is a junction with the London, Chatham and Dover Railway, a tunnel and open cutting lead to Moorgate Street Station, which is scarcely ten minutes' walk from the Mansion House terminus before mentioned, although the circuit by train occupies no less than an hour. The reader will thus perceive that the name "Inner Circle" is somewhat of a misnomer, and only justifiable in a prophetic sense; but, at the present moment, the missing section of the incomplete circle is being prepared for public use, and has, in fact, been already opened as far as a new station at Trinity Square, Tower Hill. This extension will be met by another starting from the Mansion House Station, which, passing through the heart of the City, will involve, among its most important benefits, the construction of a fine new street, which will replace the narrow and tortuous thoroughfares of Great and Little Tower Street, now so congested with traffic as to be in an almost chronic state of block. When this most important link in the chain is welded to its fellows, London will possess in its completed "Inner Circle" of under-ground railways a system worthy of the greatest city in the world, and unparalleled, though not unimitated, by its Continental compeers.

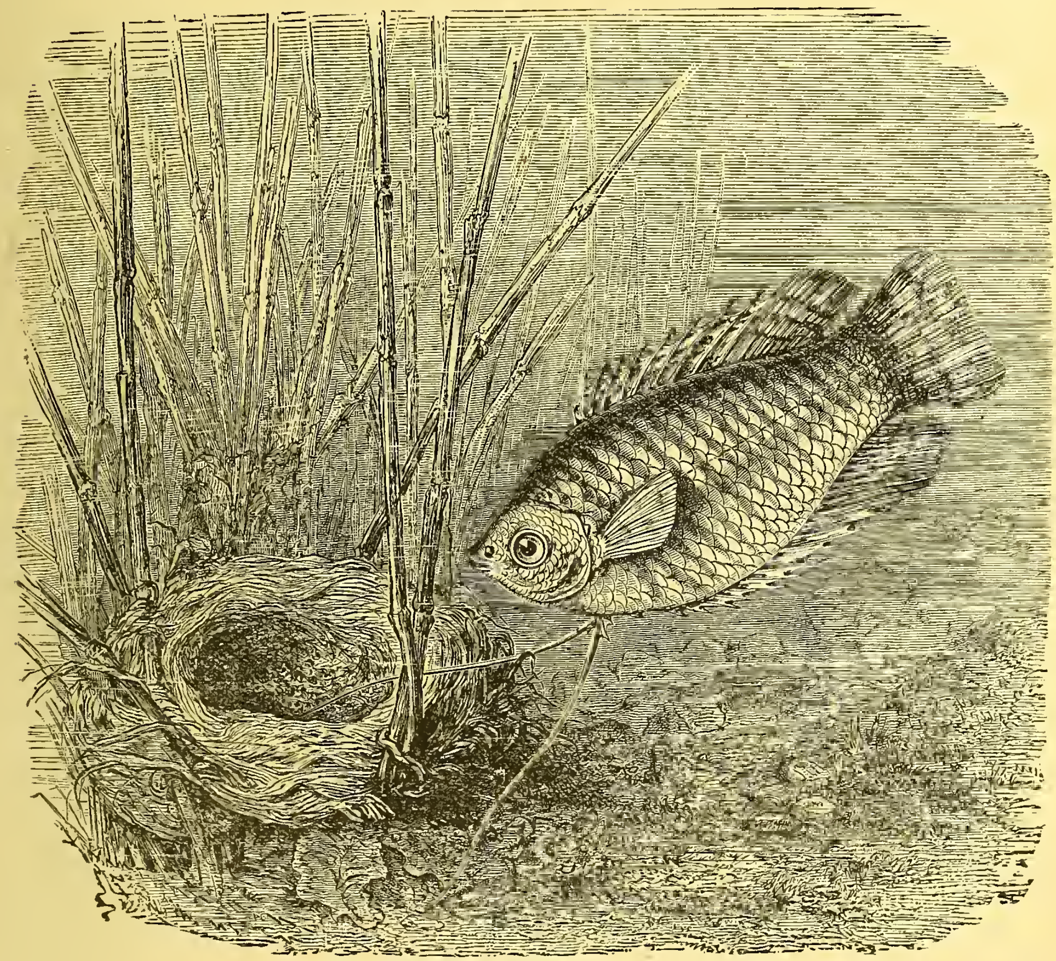
STICKLEBACKS AND THEIR NESTS.

THE NESTS OF FISHES.

No feature connected with animal life at large is better calculated to interest the observer than the relations between parent and young, and the care which animals exercise in providing for the safety of their offspring. Amongst the higher groups of animals, this relationship between parent and young is well marked. It may be credited, indeed, with the modification of higher life, and with the production of not a few of the peculiar features which that life exhibits. In lower life, the care of the young influences the parent forms in many ways. This is nowhere better seen, perhaps, than in a class of animals which are not, as a rule, credited with paying much attention to their offspring—namely, the fishes. In illustration of this remark, the Sticklebacks present us with notable exceptions to the rule that fishes are but careless parents. With these little fishes every reader must be well acquainted; but a brief description of their zoological position and affinities will not be out of place, by way of introduction to the special peculiarities they exhibit in the care of their young and in the construction of an abode.

The Sticklebacks form a special family—the *Gasterosteidæ* of the technical naturalist. In this family, some ten different kinds or species are included. The best-known of these fishes are the "Three-spined" Stickleback (*Gasterosteus aculeatus*) which is found in Britain and Europe generally; the "Four-spined" species (*G. spinulosus*); and the "Nine-spined" species (*G. pungitius.*) Of these three, the first is the most common. It is not merely an active fish, but its greed seems developed proportionately to its activity. It is extremely voracious, and is highly destructive to the young fry of other fishes. A small Stickleback, kept in an aquarium, has been known to devour in five hours no less than seventy-four young dace, which averaged a quarter of an inch in length, and possessed a diameter about that of a horse's hair. Two days after this first gorge, it ate sixty-two more, and its voracity was, even then, apparently far from being satisfied.

When the spawning season arrives, these fishes begin to exhibit an unwonted degree of activity. The male fish then sets about the work of nest-building. The materials used appear to consist of the stalks of grasses, and of similar materials. The site chosen for the nest is usually a hollow in the ground; and the foundations being first laid, the sides are erected, and finally the top of the nest is built. The grasses are cemented together apparently by a kind of *mucus*, or glutinous secretion of the mouth and skin. The average dimensions of the nest are about six inches in depth and three inches wide. The entrance is a small hole which exists at the side of the structure. The male



THE GOURAMI AND ITS NEST.

alone appears to be the nest-builder. It is only after the nest is completed that the mother-fish enters the home to deposit her eggs therein. After this process is finished, the mother-fish bores her way out through the wall of the nest, thus making a second aperture in the abode. The object of this arrangement appears to be that of securing the flow of a stream of water over the eggs —a measure calculated to assist their development. Day by day, fresh eggs are deposited within the nest, and when a goodly store of young has in this way been accumulated, the first part of the parental duty of these fishes has been accomplished.

But the labours and anxieties of the male Stickleback end not here. Reversing the general rule of higher life that the mother is the proper and natural guardian of the infantile young, the male fish now enters upon a period of unceasing watchfulness. For at least a month he rarely leaves the vicinity of the nest. Day and night he hovers round the treasures it guards, and spends his time in a state of watchfulness. Sad to relate, one of the anxieties of the male Stickleback is that of guarding the eggs from the unwelcome attentions of the female fishes. There is no question of the cannibal-like propensities of the mother-fishes. If allowed to gain access to the eggs they devour their offspring ; intuitively the male fish, therefore, keeps the opposite sex at a safe distance. When the young are hatched, the cares of the male cease. They are soon able to forage for themselves, and the nest is soon deserted and forsaken for the ordinary life of these fishes.

The habits of the Fifteen-spined species of Stickleback (*Gasterosteus spinachia*), often named the " Sea Adder," from its inhabiting the sea, are not materially different from those of the fresh-water species just described. With that adaptation to surroundings which forms one of the principal features of animal life, the marine species finds in the seaweeds, and especially in the fronds of *Zostera*, the materials wherewith the nest is constructed. The seaweeds are bound together by means of a strong silken thread resembling that which the mussels manufacture. The thread of the Stickleback seems to consist of several distinct strands : such a disposition of matters recalling to mind the fact that the spiders make their web with a thread composed of many hundreds of excessively fine strands. Mr. Couch has placed on record the curious fact that on one occasion the nest of this Stickleback was discovered in the hollow formed by the half-untwisted strands of a rope which depended into the sea. Here again the watchful care of the male fish is exercised. The eggs, which are of a yellow colour, seem to be deposited in packets throughout the meshes of the nest.

Speaking of the watchfulness of these fishes, Mr. Darwin remarked that, besides the common Sticklebacks, there are other species of which the males seem to undertake the whole duties of nurses. He says, "The male of the Smooth-tailed Stickleback (*Gasterosteus leiurus*) performs the duties of a nurse with exemplary care and vigilance during a long time, and is continually employed in gently leading back the young to the nest when they stray too far. He courageously drives away all enemies, including the females of his own species. It would be no small relief indeed to the male, if the female, after depositing her eggs, were immediately devoured by some enemy, for he is forced incessantly to drive her from the nest."

But the Sticklebacks are by no means solitary in their nest-building habits. One of the most curious members of the fish class—the Gourami (*Osphromenus olfax*)—is also a nest-builder. This fish occurs in Java, Borneo, and Sumatra, and is a fresh-water form. The body is somewhat shortened and compressed in shape, and one of the rays of the ventral fins is very long and lash-like in conformation. The Gourami is celebrated as a food fish. It is highly tenacious of life, and in the East is tamed and kept in captivity in the same fashion in which goldfish are kept amongst ourselves. This fish is a near relation of the famous *Anabas scandeus*, or Climbing Perch, whose habits will be described in a future paper. The nest of the Gourami exhibits much care in its construction, and the young appear to be tended assiduously by the parent fishes.

Amongst the nest-builders familiar enough to visitors to our own sea coasts are the " Bullheads." These fishes derive their familiar name from the large size of the head-extremity. They are near allies of the well-known " Gurnards," and are often called " Miller's Thumbs." The Bullheads are found both in the sea and in fresh waters, and the nest-building species are the common forms, the Sea Scorpion or Father Lasher (*Cottus scorpius*), and the *Cottus bubalis* or Long-spined Bullhead. Here again it is the male fishes which become the patient nurses and attendants on the developing progeny. The nest is built of seaweeds and stones, and within this erection the eggs are deposited. During the whole process of development the male fish hovers around the nest. All intruders are at once warned off, and the females, as in the case of the Sticklebacks, are carefully deterred from approaching the vicinity of the nest. The familiar " Lump-suckers " (*Cyclopterus*) also build a nest, and again it is the male on which all the care of the young devolves ; and the exceedingly curious fishes called " Hassars," belonging to the group *Callichthys*, are not merely celebrated as nest-builders, but, like the Climbing Perch, are able to travel overland for considerable distances. These fishes inhabit South American rivers, and also occur in the West Indies. Dr. Hancock tells us that the "Round-headed

Hassar" forms its nest of grass, whilst the "Flat-headed Hassar" employs leaves for that purpose. Both sexes of these "Hassars" guard the nest, and remain attentive and watchful by the side of the nest until the eggs are hatched. Dr. Hancock speaks of these fishes guarding their offspring "with as much solicitude as a hen guards her eggs," and he adds "they courageously attack any assailant. Hence the negroes frequently take them by putting their hands into the water close to the nest, on agitating which the male Hassar springs at them, and is thus captured."

It is interesting, by way of contrast to the foregoing examples of nest-construction amongst fishes, to turn for a moment to cases in which the opposite extreme of indifference to the welfare of the progeny is shown. In very many cases, the eggs are simply deposited in gravel or sand, and are covered over by the parent fishes, which sweep the surrounding materials over the eggs by means of their fins. In such a case, the eggs are simply left to be hatched by the heat of the external water, and the parent fishes take no further charge of them after the mere act of egg-deposition. When such a state of matters is contrasted with the care of the Sticklebacks, Gourami, or "Hassar" fishes, which construct a more or less elaborate nest, the variation in habits is seen to be of immense extent. A well-nigh similar instance of such variation is to be seen in the construction of the nests of birds. If we think for a moment of the elaborately-woven nest which a tailor-bird constructs, and compare this with the mere hole in the ground and the few straws carelessly placed together, which a gull or other sea-bird may construct, or which a partridge or like bird may form by way of nest, we are at once enabled to appreciate the immense differences existent between birds in respect of their nest-building habits. The Baltimore Oriole even exhibits such modifications in its habits as to utilise silk, string, worsted, and all manner of threads in the manufacture of its curiously woven nest; and even the common sparrow seems to vary its habits, according as it builds amongst trees or in houses. In the former situation this bird builds a domed nest exhibiting a high degree of skill in its construction; but when the bird finds amongst the crevices of a building a suitable hole wherein to live, it expends infinitely less labour in its work of nest-formation. What is true of birds is equally true concerning fishes. They protect their eggs in very varied ways: now forming an elaborate "nest" amid the waters; now merely depositing their eggs in the sand: but throughout their history exhibiting that wondrous adaptation to circumstances and to surroundings which not merely causes change of habits, but forms one of the most singular features of living beings at large.

HUMAN HORNS.

In the anatomical museum of the Edinburgh University are preserved four horns which were taken from the heads of four women. One, which is seven inches long, crooked, and as thick as the little finger of a man's hand, bears the following inscription. "This horn was cut by Arthur Temple, chirurgeon, out of the head of Elizabeth Low, being three inches above the right ear, before the witnesses, Andrew Temple, Thomas Burne, George Smith, John Smytone, and James Tweedie, the 14th of May, 1671. It was a growing seven yeares. Her age fifty yeares."

There is an account, which has often been reprinted, of Mrs. Mary Davis, of Great Sanghall, near Chester, who, when she was in her twenty-eighth year, was troubled with an excrescence upon her head supposed to be due to wearing a hat too tight for it, out of which thirty years after grew a pair of wrinkled horns resembling those of a ram. "She cast her horns thrice," says the old record; "the first time was but a single horn, which grew long and slender as an oaten straw: the second was thicker than the former. They did not keep an equal distance of time in falling off, some at three, some at four, and another at four and a half years' growth. The third time grew two horns, both of which were broken off by a fall backwards. An English lord having obtained one of them presented it to the French King as the greatest curiosity in nature. The other, which was the larger, was nine inches long and two in circumference, and was much valued for its novelty, being reckoned as great a curiosity as the greatest traveller can with truth affirm to have seen." Mrs. Davis died in 1668, aged seventy-four.

Sir Everard Home, Bart., F.R.S., in a paper, which appears in Vol. 81 of *Philosophical Transactions*, wrote on human horns, pointing out many other instances of their growth recorded in different countries at various times. He said, "In giving the history of a disease so rare in its occurrence, and in its effect so remarkable as almost to exceed belief, it might be thought right to take some pains in bringing proofs that such a disease does really exist: I consider the doing so as less necessary at present, there being now (1791) two women now alive, and residing in England, who are affected by the complaint." Of these two cases one was that of a Mrs. Lonsdale, a women fifty-six years old, and a native of Horncastle in Lincolnshire, and the other a middle-aged woman named Allen, residing in Leicestershire. In the first case, the first indication of this abnormal growth was a tumour on the left side of the head a little above the ear, which in course of five years gradually increased in size, until, attaining the size of a pullet's egg, it burst, and from it grew slowly a fleshy protuberance of a reddish colour on the top. At first not larger than a pea, in about three months it had grown long and thick, curling like a ram's horn, but still remaining soft; then it began to assume the horny form, and in two years and three months it was about five inches long. Maddened by the pain it inflicted, the poor woman in a frenzy strove to tear it from her head, but at first only succeeded in breaking it, the roots being extracted afterwards. At the time Sir Everard wrote, however, another was growing in its place, together with several others. In the case of Mrs. Allen the premonitory symptoms and signs of growth were precisely the same, and in November, 1790, when the writer saw her, the horn was five inches long, much contorted, and with an irregular laminated appearance. Mrs. Allen was brought to London and exhibited as a show, to the great disgust of her friends and neighbours in the country, who compelled her husband to bring her back. In the "Ephemerides Academiæ Naturæ Curiosorum" is the case of a German woman from whose head a horn grew in the way already described, and in "The History of the Royal Society of Medicine," a woman ninety-seven years old is mentioned, who for fourteen years had worn the horn. In this case the excrescence first appeared as one of several tumours; it was very easily moved, being attached to the scalp only, and although it was often sawn off, it always grew again. Bartholme in his Epistles mentions another case which he saw in 1646, when the horn on a woman's head was twelve inches long. In "The Natural History of Cheshire" a woman is spoken of who in 1668 had a wen or tumour upon her head thirty-two years, out of which, when she was in her seventy-second year, two horns grew. There used to be, perhaps still is, a specimen of a human horn in the British Museum, taken from a woman named French, who lived near Tenterden. This also first appeared in the form of a tumour. It was eleven inches long and two and a half inches in circumference when Dr. Grey saw it. Many other instances are on record, but they are all of the same kind.

There is only one instance known, so far as the writer is aware, of a man suffering from this disease. This case was that of a German nobleman, and the horn grew from the lowest vertebræ of his back. In the case of all the women mentioned above, the abnormal growth was from some part of the head, whence horns grow in other animals; and this fact is very remarkable.

VOLTAIC ELECTRICITY.

It may be taken for granted that had no other means been found for producing electricity than the agency of friction, its commercial use to mankind would have been *nil*. The electricity given by the frictional machine, and held by the Leyden jar, is said to possess high tension, whilst that given by a battery current is of low intensity. In the first case, the electricity is ready to fly off to the earth by the shortest path; in the second, we can lead it by metallic wires where and how we please; but there is, at the same time, no difference in kind between the electricity produced by friction and that which is given by a Voltaic cell. The discharge from a Leyden jar has been compared to the sudden emptying of a small cistern of water from a height. The fall will break anything in the path of the water, and will give the idea of great intensity. The discharge from a battery cell, on the other hand, is more like the gradual emptying of a reservoir. The water will flow quietly out in far greater quantity, and although it will not smash and tear anything in its path, it can, by means of a water-wheel, be made to do a far greater amount of work. It is due to the circumstance that we can control the action of the battery current that its use in the arts has become so important.

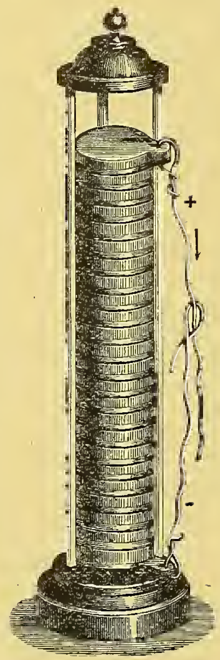


Fig. 1.—VOLTAIC PILE.

Galvani's well-known experiment in which, by touching the lumbar nerves of a recently-killed frog with a copper wire, and the muscles with a zinc wire, he caused its limbs to be thrown into convulsions, may be looked upon as the first contribution towards another method of obtaining electricity. Curiously enough, its author did not see its true bearing. Anxious to establish a theory of vital energy by the aid of what he called "nervous fluid," he attributed to the dead body of the frog mysterious powers quite unconnected with electricity. It was reserved to Volta to point out that the muscular contractions were due to the metals used, and not to any inherent power in the muscles themselves. Volta supported his opinion by pointing to an observation which, although made many years previously, had attracted little attention — namely, that two dissimilar metals placed the one above and the other beneath the tongue will give rise to a curious sensation in the mouth.

Volta's experiments were, in the year 1800, made known to the Royal Society, when he described the apparatus which he had contrived, together with the effects of which it was capable. The Voltaic pile, as it came to be called (Fig. 1), consisted of a series of plates, zinc and silver alternately, each couple being separated by a piece of cloth, or parchment, moistened with brine. With twenty of these pairs of plates, although they were only the size of a penny-piece, Volta could produce sparks, could receive an electric shock, and exhibit other signs of electrical action. Later on, the pile was given up in favour of the arrangement known as the "crown of cups." This consisted of a series of cups, each containing a zinc and copper plate immersed in liquid, the copper plate in one vessel being connected with the zinc of its neighbour. By a brief examination of one of these simple cells, we shall be better able to understand the action of the various electric batteries now in such general use.

If we immerse a clean plate of zinc in water acidulated with sulphuric acid, we shall find that the surface of the metal is gradually corroded, and that bubbles of hydrogen are given off. If, before this action has proceeded very far, we lift the zinc from the acid water, and rub it with metallic mercury, we shall find that the zinc assumes a brilliant appearance, and that it is no longer acted upon by the acid. Plates treated in this manner are said to be amalgamated, and are then fit for use in an electric battery. Taking, then, an amalgamated zinc plate, and placing it in a glass or earthenware vessel containing dilute acid, together with a plate of copper, we can watch their behaviour. For convenience of attachment, each plate should have soldered to it a copper wire. So long as the plates remain separate from one another we can detect no change, but directly the wires attached to them are brought into contact, we hear a hissing noise, and bubbles of hydrogen are given off from the copper plate. Oxygen, the other constituent of the water in the cell, is absorbed by the zinc, and a current of electricity passes from the zinc through the water to the copper, and back again through the joined wire (Fig. 2). Such an arrangement is called a closed circuit. When the plates are once more separated by releasing the joined wire, all action ceases.

As electricity is an invisible force, we can only detect its presence by certain effects, which ensue when a current passes through a conducting medium. These effects are of various kinds, and may be either thermal, chemical, magnetic, or physiological. As an illustration of the first, we may instance the heating of a fine wire, when the current is made to pass through it. The chemical effects of a current are seen in its power to decompose water, to deposit metals from their solutions, &c.

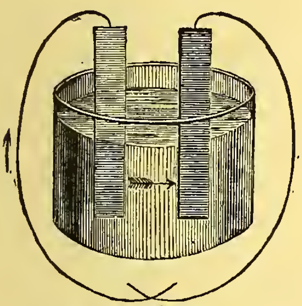


Fig. 2.—SIMPLE CELL.

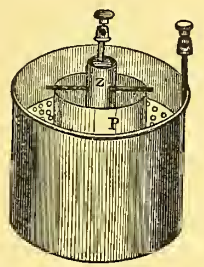


Fig. 3.—DANIELL CELL.

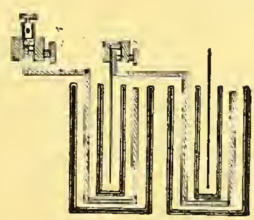


Fig. 5.—GROVE BATTERY.

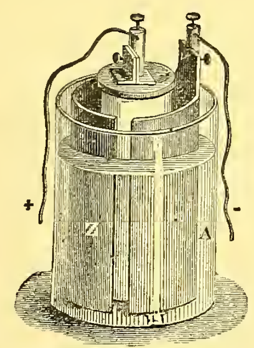


Fig. 4.—GROVE CELL.

The magnetic phenomena are seen in the power of a current to affect a magnetic needle placed near the wire through which it is passing; and the physiological effects are seen in that well-known process called receiving an electric shock. These various manifestations of electrical phenomena will receive notice in detail as we proceed.

The simple cell, consisting of a zinc and copper couple, or other dissimilar metals immersed in a suitable fluid, is found in practice to speedily lose its power. The reason of this lies in the fact that one of the plates becomes gradually covered with minute bubbles of hydrogen, so that the surface exposed is practically much diminished. Plates in this state are said to be polarised, and although the power can be again renewed by brushing their surfaces free of the bubbles, they speedily get into the same state. For this and other reasons the single fluid cell has now been superseded by batteries of a far more constant character, in which two fluids are employed. That invented by Professor Daniell, and generally known as the Daniell cell (Fig. 3), has, from its constancy, been always a favourite. In this arrangement the copper element, which it will be remembered had the hydrogen bubbles liberated upon it, is separated from the zinc by a porous partition. This partition in the first form of Daniel cell consisted of an ox gullet, but, as now made, the Daniell cell consists of an outer cell of copper, which serves at the same time as the copper element, and an inner cell of porous earthenware, P, containing a rod of amalgamated zinc, Z. The inner cell is charged with dilute sulphuric acid, while the copper vessel contains a saturated solution of sulphate of copper, together with some crystals of the same salt, to replace that which, by the action of the battery, is decomposed into the metallic state. In this battery the porous division neither stops the electricity from passing from metal to metal, nor does it interfere with the process of decomposition, but the hydrogen, instead of collecting upon the copper and stopping the action, as in the case of the single fluid cell, unites with the oxygen obtained from the decomposition of the sulphate of copper, and forms water. The copper is deposited in the outer cell in the metallic form, so that this container of the arrangement is always increasing in thickness. Another battery, which is deservedly a favourite with experimenters where great intensity is required, as in the production of the electric light, or in the exhibition of the calorific effects of the current, is the Grove cell (Fig. 4.) In this case we have an outer cell of earthenware, glass, or ebonite, A, containing a zinc plate, Z, which in order to gain surface is generally bent round or into the form of the letter U. In the hollow thus formed is placed a porous cell, containing a strip of platinum in strong nitric acid. The outer cell is filled with dilute sulphuric acid. In this cell the hydrogen decomposes the nitric acid, and as in the previous case, forms water with the oxygen set free. A modification of this cell, where the platinum is replaced by a plate of carbon, is known as Bunsen's cell, and is, on account of its cheapness when compared with the other, often preferred. When these single cells are joined together, after the manner of Volta's crown of cups, they constitute a Voltaic battery. Square troughs are most used, and the cells are connected in the manner shown in Fig. 5.

For domestic purposes—that is to say, for ringing the electric bells now so common in hotels and large houses—a battery is used in which the acid solution is replaced by a saturated solution of chloride of ammonia—commonly known as sal-ammoniac. This cell is known—after its inventor—as the Leclanché cell. It consists of an outer vessel, containing the ammonia solution, immersed in which is a rod of zinc. In a porous pot is a plate of carbon, such as can be obtained from gas retorts. In action the zinc gradually dissolves, while ammonia gas and hydrogen are given off at the carbon plate. This hydrogen speedily causes polarisation, so that if the circuit is closed for more than a minute or so the current ceases. But to obviate this the carbon is packed round with a mixture of coke and powdered binoxide of manganese. The latter material slowly yields oxygen, which combines with the hydrogen formed, so that after a short rest the cell is again available for work. The work of ringing bells being of an intermittent character, and constantly giving the cell its necessary rest, the Leclanché arrangement is specially fitted for this purpose. It will, if properly constructed, work many months without attention.

There is another form of battery, in which the porous cell is dispensed with, and the two liquids are kept apart by the heavier of the two remaining at the lower part of the containing-vessel. These are known as gravitation batteries. The Daniell cell has been thus modified by more than one experimenter, but it is not necessary to give details of the various arrangements which they have adopted. The liquids slowly mingle, so that the separation is never so perfect as when a porous pot is employed.

The various forms of batteries which have been invented, and named after their contrivers, are far too numerous to mention. Some are best suited for one purpose and some for another. The Daniell cell is largely used for telegraphic purposes, and the Leclanché cell for nearly all electric bells in houses. Bunsen's, Grove's, and what is known as the Bichromate battery, are chiefly used for experiment.

The degree to which any body is electrified is expressed by the word "potential," and the expressions "high potential" and "low potential" are used in just the same manner as we should speak of two bodies of water at a high and low level. To carry the simile still further, we might say, in a body electrified to a high potential, the electricity will, like water at a high level flowing towards that at a low level, tend to flow towards that at a low potential. The earth, whose surface is always to some extent electrified, is taken as zero for purposes of measurement, and bodies are said to be at a higher or lower potential in comparison with it.

Another term, electro-motive force—generally, for the sake of brevity, expressed by the three letters E. M. F.—requires a few words of explanation. When it is said that the zinc and copper cell already described produces a definite electro-motive force, it is meant that the chemical action due to the arrangement causes a difference of potential of a definite amount. We find, on examination, that the wire from one element is of higher potential than the other, and that the electricity flows from the higher to the lower. The chemical action going on in the cell constantly renews the difference of potential, so that the electricity is re-supplied as fast as it flows, and thus we have a continuous current.

SWISS LAKE DWELLINGS.

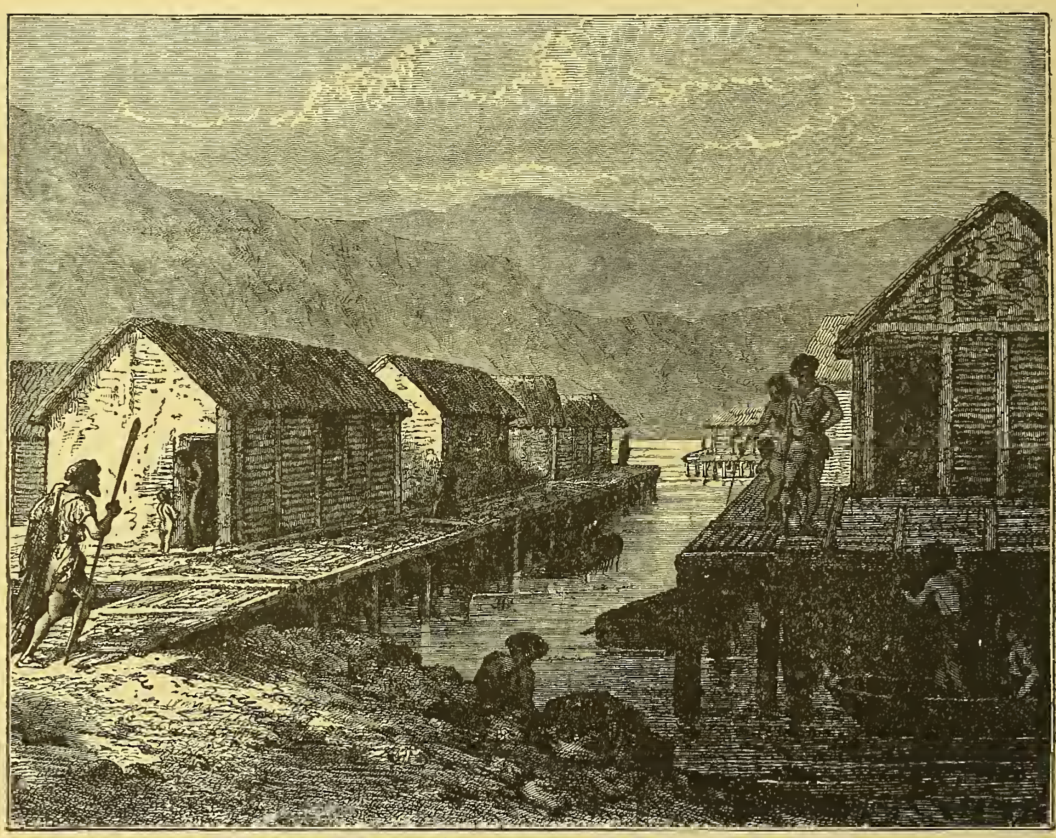
WHILE researches into the primæval history and manners of the inhabitants of other parts of Europe were being carried on slowly and laboriously, and against such difficulties as were almost insuperable, the discoveries made by Dr. Keller at Meilen, near Zurich, in 1853 and 1854, were sudden and complete, and, as Professor Vogt has said, burst upon the world like a thunderclap. In those years an extraordinary drought, accompanied by prolonged cold, was experienced in Switzerland, in consequence of which the water in the lakes fell lower than had ever before been known, laying bare large expanses of shore, and exposing to view various islands, the existence of which had not previously been so much as suspected. It was in the course of operations for the reclamation of land, undertaken during these favourable circumstances, that the first discoveries of lake habitations were made which have since led to such interesting results.

Of the Swiss lake habitations there were two kinds, described by Dr. Keller as pile dwellings and fascine dwellings, the latter of which resemble, to some extent, those lake dwellings known in Ireland as *crannoges*. They differed principally, as far as can now be judged, not in the construction of the huts, but in the formation of the substructure upon which they were erected. Examples of the pile dwellings have been found in large numbers not only in the Lake of Zurich, but also in the Lakes of Bienne, Constance, Geneva, Moosseedorf, Morat, Neufchatel, Sempach, and in many of the smaller lakes of Switzerland. The piles forming the substructure were made of a large variety of woods, and varied considerably in length, as would naturally be expected when the varying depth of the water in which they were placed is considered. They were sometimes as little as ten or eleven feet in length, but more frequently ranged between fifteen and thirty feet. The lower ends are found to be pointed, sometimes by the agency of fire, sometimes by means of stone hatchets, and sometimes with the help of bronze, and probably even of iron cutting implements. Even thus pointed, however, it is marvellous how these primitive people should have been able to drive the piles into the bed of the lake. They appear to have been placed, at least in some instances, in the direction of the cardinal points, and though generally at regular distances apart, were found sometimes in pairs, and sometimes even without any perceptible order. Their distance from one another varies greatly in different settlements, sometimes not more than a foot separating each pile from its neighbours, while in other places they are two, three, and even more feet apart. They are frequently found to have been strengthened by cross-beams below the level of the platform, and in many cases the outer piles were protected by a kind of wattle or hurdle-work, formed of small branches and twigs. Occasionally, instead of being driven into the mud, the piles were fixed, by means of a rude mortice and tenon arrangement, into split logs of wood lying upon the bottom of the lake; and sometimes—probably owing to some difficulty in driving the piles to a sufficient depth—it is found that large quantities of stones have been brought to the spot and strewn between and around them, in order to retain them more firmly in their place. A boat, still laden with such stones, has been discovered in the Lake of Bienne, serving to prove, if proof were needed, that these elevations are of artificial production.

The substructure of the fascine dwellings differs entirely from that of the more common pile dwellings. It consists of various layers of wooden material, brushwood, clay, and gravel, and seems to have been employed only in shallow lakes, or when the peaty bottom would have been incapable of supporting the weight of the settlement if erected upon the ordinary piles. The labour of constructing these fascines must have been immense. It has been conjectured that piles were first driven into the mud at distances of from twelve to twenty feet apart; that between these piles a layer of timber and brushwood was spread upon the surface of the lake, which, when of sufficient thickness, was sunk to the bottom by covering it with clay and gravel; and that by constantly repeating this process an island was at length produced, sufficiently raised above the level of the water to be suitable for the erection of a settlement. The platform upon which the huts were erected was simply laid upon the surface of the fascine structure, and sometimes consisted only of a layer of small straight stems, but occasionally, as in the lake of Niederwyl, of planks as much as two feet in breadth, and from two to three inches in thickness. In the pile dwellings, the piles were often four or five feet above the water, the heads being carefully brought to a level. Upon these the beams bearing the platform were placed, and were sometimes fixed with wooden pins, sometimes by means of a rude mortice. The platform itself was generally of rude construction, and consisted usually of one or two layers of rough stems, placed parallel to one another; occasionally, however, split planks were used for its construction. The platform upon which each settlement was built seems as a rule, though not invariably, to have been connected with the shore only by a single bridge supported upon piles, and was in some cases as much as 2,000 yards from the land, though often nearer, and sometimes within a very short distance. Its surface appears to have been covered with a coating of loam, clay, and gravel, while occasionally a layer of large pebbles formed a sort of pavement throughout its whole extent.

The huts varied considerably in size in different localities—in one case they were 27 feet long and 22 feet broad, in another, 20 feet long and 12 feet broad. They appear generally to have been arranged upon the platform with considerable regularity, and in some cases at least were no more than from two to three feet apart. The framework consisted of piles similar to those supporting the platform, and often shows no little skill in the workmanship. The walls between the framework were of wattle, covered with a thick coating of clay, large pieces of which, still bearing the impression of the wattle, have been discovered in a burnt state, proving the destruction of the settlement by fire. Generally there appears to have been a sort of skirting-board round the outer wall of each hut, but hitherto it has not been decided whether the huts were divided into separate apartments. They were almost invariably of rectangular form, though evidence of circular dwellings has been discovered. From remains which occur upon different sites, they are proved to have been thatched with coarse straw and reeds. They were sometimes furnished with wooden doors, fixed either by a rough wooden hinge, or by means of cords of leather or flax, and holes have been found in these doors, indicating probably the use of bolts. Each hut was furnished with a hearth, consisting of three or four slabs of stone, showing that the lake dwellers possessed the comfort of an indoor fire, while the presence of heaps of soft hay and straw in certain localities has led to the belief that their dormitories were thus furnished.

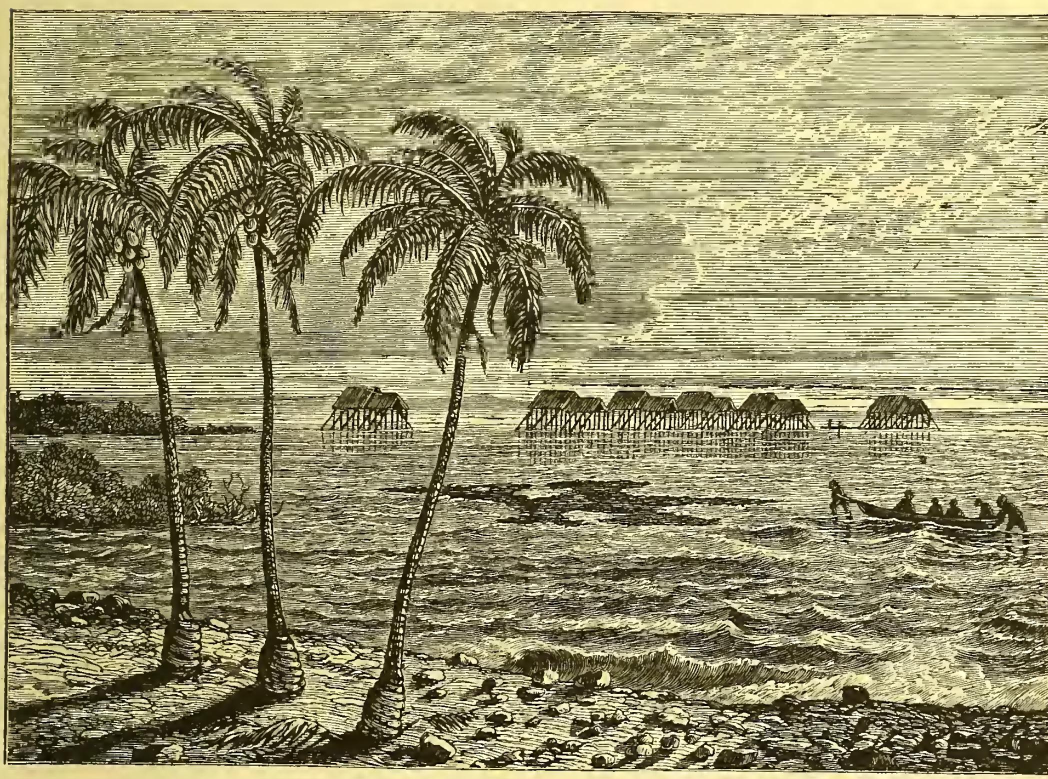
Such were the results of Dr. Keller's careful investigations of these Swiss lake dwellings. Of their inhabitants not much is known, but from the very few human bones which have hitherto been discovered, they seem to have been of rather low stature, and well and delicately formed. One of the skulls is described as closely resembling that of a young man of the present day in Switzerland, the forehead being high and regularly arched, and the brain-cavity of considerable size. That they took their rise in what has been termed the stone age is proved by the presence in some of the settlements of implements made of no other material. Other settlements contain only bronze implements, while in a great number the stone



RESTORATION OF A LAKE SETTLEMENT NEAR THE SHORE.

and metal are so mixed together as to warrant the belief that the two periods were continuous, and presented no marked line of separation. Nor, during this long space of time, estimated at about 4,000 years, does any change appear to have taken place in the race of the lake dwellers, though undoubtedly they acquired, as time went on, such knowledge and experience as rendered them immeasurably superior to many of the savage races of the present day. There can be no doubt that these lake settlements were really the habitations of the people, and were adopted as a means of protection for themselves and their cattle against the attacks of neighbouring predatory tribes. Upon their platforms were erected not only huts for themselves, but also stalls for their domesticated animals, the excrements of cows, sheep, pigs, and goats having been frequently met with in this situation, together with the litter they had used.

They must have been an essentially agricultural race. In almost every hut are found what have been described as corn-crushers and mealing-stones, the latter being almost identical with similar instruments observed by Dr. Livingstone in use on the Zambesi; and flails and other agricultural implements have occasionally been found. Rye appears to have been entirely unknown, but at an earlier or later period several species of the commoner cereals were possessed, including barley, millet, oats, and wheat, the Egyptian wheat being amongst them. Not only have large quantities of these grains been found on different occasions, but also fragments of bread, which appears only to have been made of wheat and millet, with occasionally a slight admixture of linseed. It is not remarkable that few remains should have been discovered of culinary vegetables, but in settlements of the stone age, peas, and later, small beans and lentils, have occasionally been met with. Apples in large quantities, pears, cherries, sloes, raspberries, blackberries, and strawberries have also been found in a more or less fragmentary condition, as well as nuts of different kinds in some abundance.



MODERN LAKE VILLAGE OF THE MARACAIBO INDIANS.

Some of the domestic animals of the lake dwellers have already been enumerated; of oxen they possessed two varieties, and they also turned to their service the horse, and at least two varieties of dog; indications of the presence of rats and mice have also been discovered, but the domestic cat seems to have been almost unknown, though bones of the wild cat have been met with. Nothwithstanding that they were skilled in agriculture, and bred their own cattle, there can be no doubt that to the chase they were largely indebted for their means of subsistence, and the large number of bones of the stag and the wild ox prove that these two animals were their staple article of food, while the remains of other animals, birds, beasts, fishes, and reptiles, have also been found in greater or less abundance. Fish were sometimes captured by means of a sort of night-line, and sometimes in wicker baskets, of similar construction to the eel-baskets of the present day. Their fish-hooks were generally of boars' tusks, often very carefully worked, though in later times they are found of bronze, and sometimes of iron. From the way in which the carcases of the larger animals were cut up, it is supposed that there must have been professed butchers, who used not only axes and hatchets of various kinds, but also saws, which at first consisted of pieces of flint, sometimes six or seven inches in length, and serrated upon one or both sides, but were afterwards made of bronze. Besides flint and bronze, a large number of implements, some of very beautiful construction, were of horn, bone, and jade or nephrite; the presence of the latter substance leading to the belief that even at that early period the people of Switzerland must have had trading relations with peoples inhabiting those eastern countries whence alone nephrite was then to be obtained.

Though doubtless largely indebted to the furs and skins of various animals for their clothing, the lake dwellers were not wholly dependent upon this source, as they cultivated flax to a large extent, and used it not only in the manufacture of cords and ropes, but also for making cloth of various qualities and fineness. That the art of weaving was universal in these lake settlements is proved by the presence, in almost every hut which has been examined, either of the remains of weaving-looms, or of clay weights for weaving, and of spinning whorls. The cloth is generally of coarse texture, and occasionally the yarn employed was almost as thick as fine string. That shoes of some kind were worn is shown by the remarkable discovery of a shoemaker's last. It is of wood, and instead of being hollowed into the shape of the foot, is perfectly flat upon the sole. The shoes were probably made of untanned leather, and to them were doubtless attached in the winter season the skates, made of the long bones of the horse, and measuring some ten or eleven inches in length, which have occasionally been met with in these ancient settlements. Possibly they were reserved for this purpose alone.

Though indications of the use of the potter's wheel are of rare occurrence, yet the many fragments of pottery which have come to light show that the lake men possessed great skill and no little artistic talent in the making of pottery by hand. It would, however, be impossible here to give any lengthened description of the various domestic utensils which have been discovered. Some beautiful horn cups have also been found, and, of a later date, bronze cauldrons and other vessels, knives, and even spoons have been met with. It is interesting to note that some of these metal utensils have been repaired with solder, and that a fragment of an earthenware vessel has been found which had evidently been broken and repaired with asphalte.

That these people were ignorant of the art of writing cannot be doubted; nor has it been possible to gain any insight into the nature of their religion. It has, however, been proved that they were in the habit of burying their dead in tumuli upon the land, and several of these have been discovered and examined. In one of them the remains of a large number of individuals were found, and from the position of the bones it was obvious that they had been deposited in the tomb after the flesh had been removed from them, many of the small bones of the hands and feet being placed within the skulls.

Of the age of these lake dwellings various estimates have been made. That they existed during the ages of stone and bronze, and in some cases even to the subsequent age of iron, has been satisfactorily proved. These ages are, however, arbitrary divisions, indicating only the *local* age of the various settlements, and not their age as compared with other parts of the world; and remains of now extinct animals show as much the more recent date of these, as the greater age of the contemporaneous human remains. It has, however, been estimated by geologists that the age of the earliest "stone" settlements is about 6,000 years, and that of the first of the bronze habitations about 2,000 to 3,000 years, while some of these lake-dwellings were probably still inhabited far into the Christian era. Even as late as the last century there were on the River Limonat, in the neighbourhood of Zurich, several fishing huts built upon the same plan—a survival, perhaps, in this limited space, of a custom which had once been universal throughout Switzerland.

Nor was Switzerland the only country in which this mode of life prevailed. Numerous remains of these lake habitations have been met with in Northern Italy and elsewhere in Europe, and Herodotus describes a Thracian tribe which, in the year 520 B.C., was settled in Prasias, a small mountain lake of Pæonia. Their huts were built upon a platform of planks, supported upon piles placed in the middle of the lake. This platform was of considerable extent, for upon it dwelt, not alone the Pæonians and their families, but also their cattle. For their means of living they depended chiefly upon the supply of fish from the lake, upon which strange food they are also stated to have foddered their horses. This aquatic settlement was adopted as a protection against aggressive neighbours, and the inhabitants even resisted the attacks of Darius, and preserved their independence during the Persian invasion. In the country of the Caucasus and throughout the East, particularly in the Malay Archipelago, similar dwellings are still to be seen. They were met with by Dumont d'Urville in his voyage of discovery to New Guinea, and still exist in some parts of America, the City of Mexico having been, at the time of its conquest by the Spaniards, a huge lake dwelling of not dissimilar construction. Our second illustration shows a lake settlement of to-day, belonging to a tribe of the Maracaibo Indians in South America. Thus, throughout the world primitive races appear, after having acquired a certain degree of civilisation, to have resorted to this mode of existence ; and it was probably when civilisation became still more advanced, when this mode of protection was no longer needed, or no longer adequate to the times, that they deserted their fragile aquatic settlements for more stable habitations upon land.

ORIGIN OF A NEW WORD.

RICHARD DALY, proprietor of the Smock Alley Theatre, Dublin, in the year 1791, had an extraordinary propensity for making wagers. Hearing an actor described in French as *un fagotin*, a term for which it was argued there was no English equivalent, a discussion arose, in the course of which he offered to bet twenty guineas that within forty-eight hours a perfectly new word should be in the mouths of nearly all the people in Dublin, and within a week begin to be commonly used, with a new and definite meaning attached to it. The bet was accepted by Alderman Moncrieffe in combination with three others who were present, and the stakes were duly deposited. After the performances of his theatre were over, Daly wrote a word on each of a dozen or two cards, and giving one to each of the call-boys, scene-shifters, carpenters, and supernumeraries, with a lump of chalk, directed them to perambulate the city until daybreak, chalking the word upon as many doors and shutters as they could. The next day was Sunday, and upon the doors of shops, warehouses, and private dwellings, this one word appeared, in every direction, creating no little wonder and alarm. Some believed it to be the watchword of a secret society, and the signal for some unlawful slaughter-house doings ; some believed on first seeing it that it was a nickname for themselves ; all over Dublin it was talked about, discussed, and wondered at. After a few days the general conclusion was that it meant nothing more than a joke, a mere trick to set people talking, only the hoax of some one who wanted to humbug and laugh at the entire population of the city. But the word was never forgotten, and it is now in common use, with a well-defined meaning attached to it, in India, Australia, America, Canada, in short, wherever the English language is spoken. The word was the now expressive, but at first meaningless, one—QUIZ.

THE PHONOGRAPH.

THE endeavour to imitate vocal sounds by mechanical means has been a favourite pursuit of inventors for ages. The inarticulate sounds of animals have not presented an insurmountable barrier to their inventive powers, and one of the best known achievements of this kind is the common cuckoo clock, which emits pretty faithfully the notes of the bird every time the long finger points to twelve on the dial-plate ; but for the articulate sounds of human speech, thoroughly effective machines were not devised—notwithstanding the labours of Faber, Kratzenstein, Kempelen, Mical, Willis, Wheatstone, and others—until, in 1877, Thomas Alva Edison invented the Phonograph.

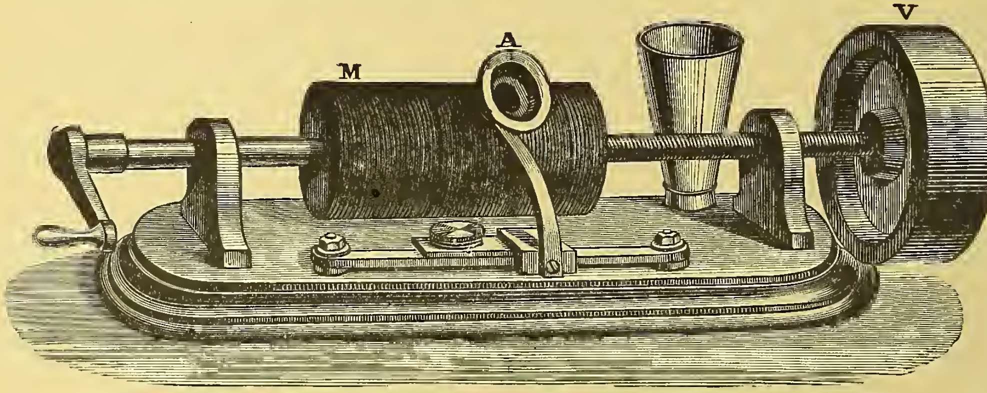
The Phonograph is an instrument into which one speaks while its cylinder, covered with tin foil, is revolving. The speech is, so to speak, impressed on the tin foil, and by a simple process the machine may next be made to speak out what it may be said to have heard. The parts of the Phonograph are few and simple. There is a cylinder, M, with a spiral groove running round it. The shaft on which the cylinder is fixed is also grooved to the same pitch, so that when the handle is turned round, the cylinder, besides revolving, has a lateral motion, which slowly carries it past the mouthpiece. This lateral motion may be caused by either a female screw or a knife-edge acting on the groove of the shaft. The mouthpiece, A, is of some importance, for it performs the function of an ear in receiving sounds, and of a mouth in again uttering them. At the bottom of it there is a thin disc of ferrotype fixed at the edges, and this disc is in communication with a movable style of metal, so placed, that it is always opposite the groove of the cylinder. Before being used, the cylinder is covered with tin foil, and its motion is made uniform, either by means of clock-work or by having a fly-wheel, V, at one end of the shaft.

The power of sound to make things vibrate, as when the rolling notes of an organ shake the beams in the roof of a church, is well known. Here also, when a person speaks with his mouth close to the mouthpiece of the phonograph, the vibrations of the air which have been created by the voice are imparted to the disc of ferrotype. This disc, or drum—for it acts like the drum of the ear—vibrates, and moves the style connected with it backwards and forwards. As the cylinder covered with tin foil revolves in front of the kicking style, it is indented more or less, according to the nature of the sounds which are causing the drum and the style to vibrate. Sound is then stamped on to the tin foil as a series of minute ridges and valleys, which appear to the naked eye as so many dots and dashes on its surface.

The operation of making the phonograph give out its sounds is now a very simple one. The cylinder is slid back, and the point of the style is placed in the very first dent it made in the tin foil. The cylinder is now revolved as near as possible at the old rate, and the style, pressing gently against

ducing s sounds. Thus when words like *boys*, *shall*, *steady*, *fleece*, and *last* were spoken against the whole diaphragm, the hissing sounds were not faithfully produced ; but by the use of a small hole provided with sharp edges Edison found that the difficulty was got over.

The phonograph is really a marvellous machine : marvellous in its simplicity and marvellous in its powers. When it was first shown before the French Academy in 1878, one of the members, M. Bouilland, openly asserted that deception was being practised, and that the results obtained must be the work of ventriloquists. The phonograph is, however, a reality, and one of the most marvellous inventions of this century.



THE PHONOGRAPH.

the foil, is pushed rapidly backwards and forwards by the succession of ridges and valleys passing past its point. This causes the ferrotype plate it is connected with to vibrate again, and in vibrating it emits similar sounds to those which were originally uttered in front of it, although, of course, very much weaker.

By such a series of operations as we have described, one may obtain from the phonograph either a speech or a song, yes, and even the combination of several voices, as in a chorus. The sounds are, of course, not so loud as the original, and there is even something comical in them when they are first heard, but the individuality of the voice is perfectly recognised. The loudness of the sounds emitted by the phonograph (or by the telephone) may be increased by taking a sheet of stiff paper, and rolling it into a cone, with the apex of a sufficient size to insert into the mouthpiece. Such a cone materially increases the sound, by preventing it from spreading out to the extent it would otherwise do. Cones of different materials are usually employed ; perhaps tin is as good as any.

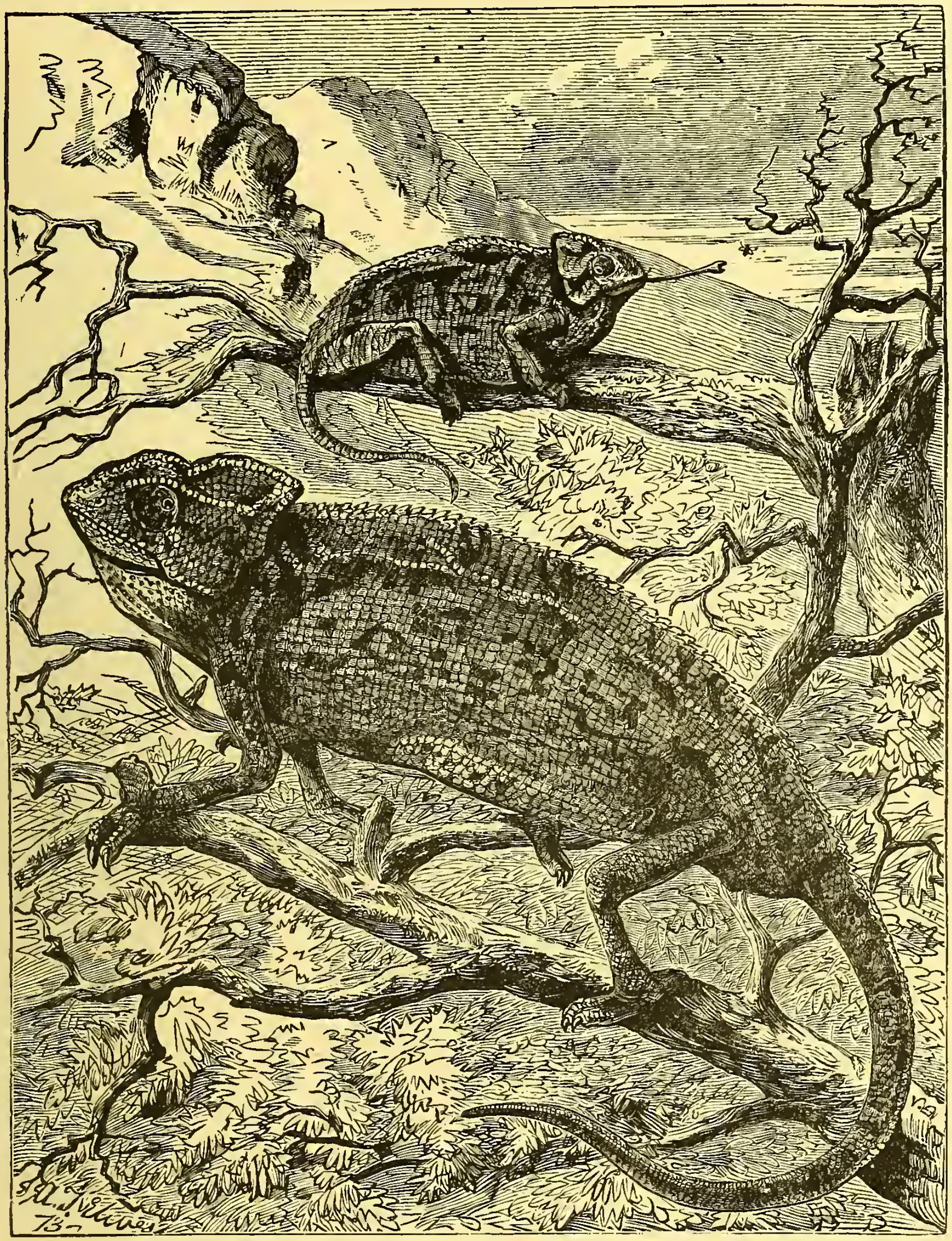
With regard to the phonograph's articulation, it was early found that it had a difficulty in repro-

THE CHAMELEON.

ALTHOUGH the Chameleon does not live in this country, it is well known to most people from Merrick's popular poem, and it is perhaps one of the most wonderful animals in the world to the ordinary observer. It is grotesque to look upon, with its thin legs, feet with opposable toes, scaly coat, saw-like ridge on its back, creased neck, and a triangular head with a pyramidal prominence at the top.

Seen from a distance it appears to be feeding on air, as it darts out its worm-like tongue with amazing swiftness ; and that such was the case was really believed by the ancients, Pliny remarking—" It always holds the head upright and the mouth open, and is the only animal which receives nourishment neither by meat or drink, nor anything else, but the air alone." The truth is, however, that the chameleon lives on insects, and not on air. It will watch patiently until an insect is only a few inches off it, and then it strikes it with its tongue, and the insect adhering to this sticky organ is at once brought into the mouth.

The most remarkable thing about a chameleon



CHAMELEONS

is its power of changing colour, under the influence of fear, rage, and variously-coloured lights. Mr. H. M. Middleton, who had five chameleons in captivity, recently made the following notes of their behaviour :—"When a large Algerian chameleon (*Chameleon vulgaris*) now in my possession," says he "perceives a common snake wriggling in its vicinity, it at once inflates its body and pouch, sways itself backwards and forwards with considerable energy, or walks rapidly away with its body leaning over in the direction farthest from the snake, opening its huge cavernous mouth, hissing, and even snapping at what it evidently regards as its natural enemy. At the same time its body assumes an almost instantaneous change of colour, and is quickly covered with a large number of small dark brown spots. It is curious that similar symptoms of fear and anger are displayed when a lizard (*Lacerta viridis*), or even a tree-frog (*Hyla arborea*) is exhibited to them. The climax of grotesque nervousness was, however, reached one day, when the sight of a child's doll produced the like effect ; in this case it is probable that the glass eyes of the doll giving to it the appearance of life were what caused this terror in the reptile."

This colour-change in the chameleon is a curious one, and has given rise to many surmises in ancient times, and investigations in these days, as to its cause. Aristotle thought the colour-change was caused by the chameleon inflating itself with air, and it is only comparatively recently that naturalists have begun to attribute the change to the working of the emotions and passions of the animal. Milne-Edwards has shown that whatever the exciting cause may be, the colour-change is only rendered possible by the presence of two layers of differently-coloured pigments in the skin, capable of displacing each other, or of appearing simultaneously at the surface ; the colour of course varying with the amount of displacement, etc. And M. Bert has recently made experiments showing the effect of variously-coloured lights, and of the agitation of sections of nerves on the colour-change. Thus a chameleon was placed under the influence of coloured sun-light, red light being made to fall on the fore part of the body, and blue light on the hind part. Its body seemed divided into two portions, the anterior part being of a clear green with red spots and the posterior of a darkish green. Again, the spinal cord of a chameleon was cut into at two places, and upon exciting at one point the portion which led to the hind part of the body, and at the other that portion which led to the head and brain, &c., it was found that the part of the body between the nerves, which had not been excited, remained of a dark tint, while the fore and hind parts, to which the excited portions of the cord sent off ramifications, became of a clear green.

In the natural state the chameleon changes its colour to some extent so as to make it correspond with its surroundings. Thus a chameleon which was seen walking on the top of a dark old wall at Ephesus was noticed to change its colour as soon as it got on to one of the blocks of white marble with which the wall was here and there varied. It appeared to accommodate itself at once to the altered nature of the material it was walking over, becoming as near the same tint as it was possible for the animal. By similarly assuming the tints of the foliage among which it may be moving, it is supposed to keep out of sight of its enemies, and at the same time insects may be deceived into coming within the length of the animal's tongue, when they fall a prey to it.

The chameleons are widely distributed, being found in Southern Europe, Africa, Asia Minor, Hindostan, and Ceylon. There are a great many species, the best known being the common chameleon (*Chameleon vulgaris*), which is found in Southern Asia and Northern Africa. It soon dies in England, but will live in the warmer southern countries of Europe.

SPEAKING IN UNKNOWN TONGUES.

In 1831 public attention was called to some extraordinary doings at Port Glasgow, where it was said the gift of speaking in "unknown tongues" had fallen upon a family of great piety and respectability named Macdonald, and was fast spreading to others. Mr. Cardale, of Bedford Row, London, visited Port Glasgow, and stayed there three weeks for the purpose of investigating the case, attending regularly private meetings, which took place every evening. After reading from the Bible and praying, addresses were delivered by some of those present, several being spoken, or rather chanted, in a perfectly unknown language. Mr. Cardale said:—

"The tongues spoken by all the several persons who had received the gift are perfectly distinct in themselves and from each other. J. Macdonald speaks two tongues, both easily discernible from each other. I easily perceived when he was speaking in one tongue, and when in the other tongue. J. Macdonald exercises his gift more frequently than any of the others ; and I have heard him speak for twenty minutes together, with all the energy of voice and action of an orator addressing an audience. The language which he then—and, indeed, generally—uttered is very full and harmonious, containing many Greek and Latin radicals, and with inflections also, much resembling those of the Greek language. I also frequently noticed that he employed the same radical with different inflections, but I do not remember to have noticed his employing two words together, both of which, as to root and inflection, I could pronounce to belong to any language with which I am acquainted. . . . . The only time that I ever had a serious doubt whether the unknown sounds which I had heard were parts of a language was when the Macdonald's servant spoke during the first evening. When she spoke on subsequent occasions it was invariably in one tongue, which was not only perfectly distinct from the sounds she uttered at the first meeting, but was satisfactorily established, to my conviction, to be a language."

It is not necessary to attribute conscious deception to those who take part in such manifestations, which have appeared during many periods of excitement. Self-deception, it is probable, is more commonly the case. But Mr. Cardale was, it is to be feared, very easily satisfied, and scarcely competent to deal with the matter.

EXTRAORDINARY SYMPATHIES.

We read and hear continually of unaccountably singular sympathies which have leaped into being between individuals who, meeting for the first time, have recognised, as it were, each other's thoughts and feelings. Mr. J. G. Millingen, M.D., M.A., in the second edition of his work on "Medical Experience" tells a story of this, which runs as follows :—

"A brother officer of mine was a man of taciturn and retired habits, seldom frequenting public places of amusement, and, when doing so, feeling anything but gratification. He was, however, one evening after dinner prevailed upon to go to a ball. We had not been long in the room when, to my utter surprise, he expressed great admiration of a young lady who was dancing ; and what still more amazed us all, he engaged her to dance. Such an act struck us all as a singularity only to be accounted for by an unusual indulgence at table, although we knew him to be habitually abstemious. We were unjust to him. The dance was scarcely over before, with a look of utter despondency, he told me that his lovely partner was a married woman. The air of deep grief with which he addressed me was truly ludicrous. A few minutes after he left the ball-room. His strange conduct awakened doubts of his sanity. I was alarmed, and he confirmed my melancholy impression of his mental condition when he told me, on the following morning, that he was satisfied that he would be married to the object of his sudden affection, whose husband was a young and healthy clergyman in the neighbourhood. Here matters rested, and we both went abroad. We did not meet until three years after, when, to my utter surprise, I found that his prediction had been verified. The lady's husband had died through a fall from his horse."

The strangeness of this story is increased by the additional fact, that precisely the same impression was made at the same time on the mind of the lady, who, on returning from the ball, told her sister, with deep emotion, that she had danced with a gentleman who was a complete stranger to her, and was convinced that she would some day become his wife. The conviction long embittered her life, for the impression, despite all her efforts, could not be removed.

Another instance of this kind, for the truth of which we can vouch, may be found in the following facts :—

An artist and novelist, still in harness, visited a house on business, where he was ushered into a parlour and introduced to those present—amongst others to a near-sighted bashful young lady, who was so busy with needlework that all he saw of her was the parting of her fair hair. When he had gone she asked her aunt who the visitor was, and what he was like ? She was afraid to look at him, and although it seemed likely that she might never see him again, she knew she would, and dreaded his coming, for, said she, "I don't like him, and he will be my husband." They have been married more than twenty years, and we have private reasons for believing that she did and does like him very much indeed.

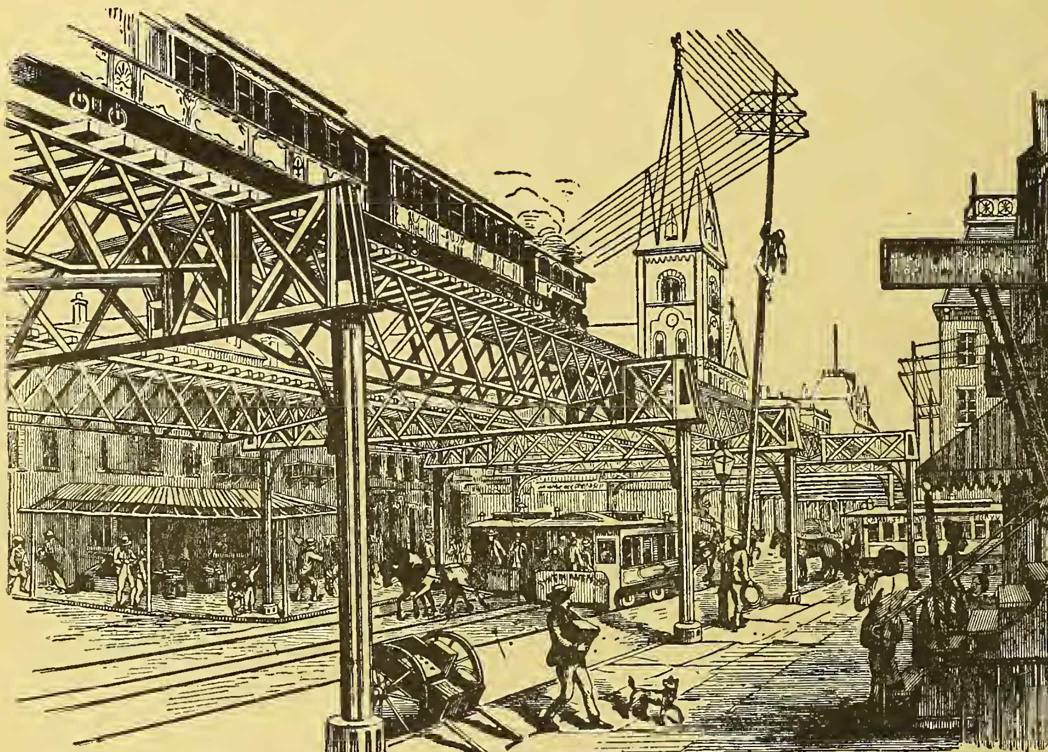
It was an attempt to govern these mysterious sympathies between the sexes which originated a superstitious belief in the guarding power of charms, amulets, love-philters, and magic potions. That a sympathetic fondness could be transmitted at will, from one person to another, by the use of certain substances, is a theory of great antiquity not yet altogether exploded. In Italy, Portugal, and Spain, a belief in their potency is still to be found. Plato warned the husbands of antiquity to guard their wives against the influence of such secret enemies. Virgil mentions them as genuine sources of power, and by the laws of the Twelve Tables the practice of such enchantments was made punishable by death. When the bride of Marc Antonius fell passionately in love with an actor, it was supposed that she was under the influence of a love-charm, to counteract which a potion was administered to her containing some of the comedian's blood. Petrarch tells a story of Charlemagne being compelled to love a fair dame who carried the charm which controlled him to her will under her tongue, where it was found some time after her death. Its removal destroyed the bond, and not before it was taken away could the great king be induced to part with her embalmed and magnificently-coffined body. From that time forth Charlemagne regarded everything that reminded him of her with horror. St. Jerome, in the "Life of Hilarius," mentions a similar case.

These marvellous potions for the creation of unnatural sympathies were composed of curious ingredients. Mandrake-roots, the clothes of the dead, one particular hair plucked from the tail of a wolf, the heart of a swallow and a dove's heart reduced to dust, donkeys' brains, vipers' tongues, and a vast number of other things, including nail-scrapings and chopped hair.

By what means the serpent-charmers exercise control over venomous snakes is a mystery still unexplained. The power has existed from remote times, and whether it is natural or artificial cannot be confidently said. The ancient Cyrenaica being infested with poisonous snakes, it was found that one tribe, the Psylli, were able by the mere effort of their will to render them harmless. Cato is said to have carried some of them with his army when he pursued Juba into the Cyrenaica desert, to protect the soldiers. Bruce is responsible for the statement that in the kingdom of Sennar the blacks exercise the same influence ; neither scorpion nor viper would bite them.

THE "ELEVATED" RAILWAYS OF NEW YORK.

THOUGH the extent and population of the great American metropolis are far inferior to those of London, yet the inhabitants of the former city have, like those of the latter, felt the pressing necessity of some means of communication which should afford greater facilities than those offered by ordinary road traffic. This need, satisfied in London by the system of "Under-ground Railways," of which we gave an account at page 52, has been met in New York by the singularly contrasting expedient of "Aërial Railways," constructed along the principal streets, and raised at a considerable height above their level. In some respects this system compares favourably with that of the subterranean lines so successfully adopted in London and in certain Continental towns. The whole line, as well as the covered stations and platforms, erected, like the line itself, on columns and girders, is light, airy, and free from dust, and the cost of construction was of course very much less than that of an under-ground railway. No sewers, water-pipes, or other subterranean conduits had to be diverted and re-arranged; no expensive house property had to be acquired; and no difficulties of lighting and ventilating had to be surmounted. On the other hand, the railways, though as light and ornamental in character as the exigencies of their construction admitted, cannot be considered as an improvement to the appearance of the city streets, although at some points effects of a certain picturesqueness are not wholly absent. It is also admitted that the aërial railways, in spite of their elevated position, produce a certain amount of inconvenience in crossing the narrower streets, and that the noise caused by the passage of the trains alarms the horses in the roadways beneath.

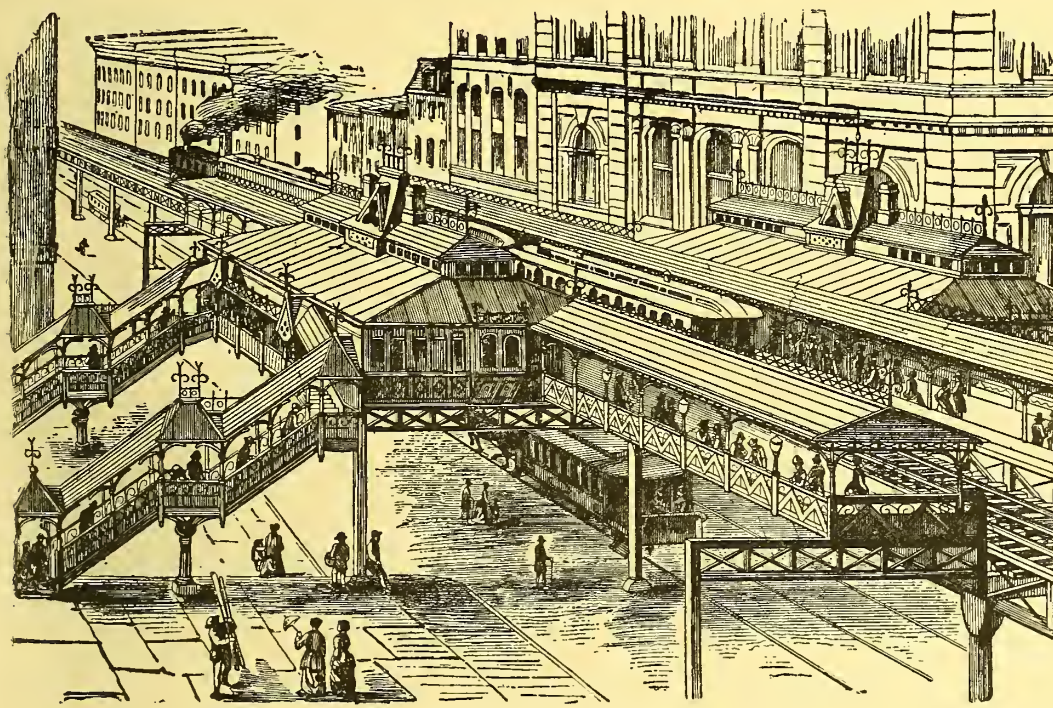


NEW YORK ELEVATED RAILWAY.

The details of construction of the aërial system do not offer any particularly interesting features, and our illustrations amply indicate their chief points. It only remains to add that, in order to prevent the possibility of a train running off the rails, a strong beam is in some parts of the line firmly fixed outside and a few inches above the rail, while in the newer portions of the railway the beam is placed inside the lines of the rails, and the outside is guarded by a strong wooden framework.

As in the case of one of the earliest railways from London (the London and Blackwall line), the first "elevated" railway in New York, though constructed nearly forty years later, was to have been worked by a stationary engine and cable, but this plan was abandoned for the ordinary system of locomotives, constructed, however, on a smaller scale than usual. As on most American lines, the carriages are of considerable length, entered at either end, and mounted on a pair of "bogie-trucks," small frameworks placed at the ends of the carriage, each carrying two pairs of wheels, and both turning freely, like the lock of an ordinary four-wheeled vehicle. By this arrangement much sharper curves can of course be passed than by the ordinary form of carriage. The system of fares is simple, being limited to a charge of 10 cents (5*d.*) for any distance, except between the hours of 5 and 8 a.m., and of 4.30 and 7.30 p.m., when the fare is 5 cents. This is tolerably cheap for long distances, but for short distances the tramways are, no doubt, preferred. The charge by tram is also uniform, but is one-half the figure named above. The cost of travelling by train or tram in New York is therefore only a little dearer than in London; but the use of cabs does not by any means offer an economical alternative, the charges being 1 dollar (4*s.* 2*d.*) for the first two miles, and 1 dollar per hour if hired by time.

A glance at a map of New York reveals some striking peculiarities. In the first place, it is seen that the city is built chiefly upon an irregularly-shaped island 13½ miles in length, and 2¼ in width in its widest parts. Its area is nearly 22 square miles, and it lies about north-east and south-west, in the direction of its length. The second striking feature is the great regularity of the streets, which are almost invariably perfectly straight, and cross one another exactly at right angles, so that the whole town is cut up into a multitude of rectangular blocks of buildings. Most of the roadways running across the island retain the name of streets, and are numbered, while those traversing the island lengthwise are called "Avenues," and are also numbered. There are twelve of these numbered "Avenues," and no less than 190 of the numbered streets. The general plan of the Aërial Railways of New York will now be better understood when we say that they all start from the south-western end of the island, and diverging more or less from one another in direction, traverse its whole length by passing chiefly along



BATTERY STATION ON THE NEW YORK ELEVATED RAILWAY.

the "Second," "Third," "Sixth," and "Ninth" "Avenues," with numerous branches along the cross "streets," and occasional changes from one avenue to another; while in the central part of the city there are, for a distance of five miles, two parallel lines of Elevated Railways, only 250 yards apart.

It will thus be seen that these lines are as different from London's Under-ground Railways in their general plan as they are in their mode of construction. In fact, while we pass under-ground our American cousins pass overhead, and while we surround our town as with a girdle they traverse theirs almost "as the crow flies," in more senses than one. It would, of course, be nearly impossible for Londoners to follow the plan adopted in New York. The irregular, and in many places narrow and tortuous, streets of London would render "Aërial" Railways a practical impossibility, and it is doubtful whether they would be tolerated even in our widest roadways. In New York, however, their success has been remarkable. Four years ago, scarcely nine miles of these railways were completed, and at the present time nearly twenty-six miles are in operation; whilst in addition to these "aërial" lines, New York possesses between fourteen and fifteen miles of ordinary railway, constructed chiefly on a level or in cutting.

The need for this ample supply of railway accommodation is by no means evident if the mere population of the city itself be the only question considered. The census of 1880 gives the population as 1,206,500, but this figure conveys almost as erroneous an idea of the importance of New York as would be derived from a census confined to the "City" of London. Dealing with New York and the adjacent localities on the same plan as that usually applied to London, the population of the former city would be found to be nearer 2,500,000. The localities alluded to are not merely residential, and are all accessible by a large number of ferries and a very few bridges. Again, the importance in a commercial point of view of this, the chief port of the United States, may be estimated from the facts that about three-fifths of the entire foreign commerce of the States passes through the port, and that about 20,000 vessels arrive and depart each year.

Considering these circumstances, it is not surprising that New York should possess, in addition to the railways described above, a complete system of tramways, or, as they are called on the spot, "street railways." The latter, however, are much more numerous, there being no less than twenty-six, seventeen of which run across, and nine along the island, while there are also seven branches in various directions. The railways are, however, by far the most striking feature of the traffic.

PRODIGIES OF SLEEP.

THERE is a case, read before a society of physicians in 1756, and recorded in "The Philosophical Transactions," of a woman named Elizabeth Orvin who never, for ten years, slept less than seventeen hours out of each four-and-twenty; and who in 1738 slept through four successive days. Dr. Brady says some very strange methods were resorted to for the purpose of arousing her, such as rubbing her bare back with honey and exposing it to bees, running pins into her flesh, and flagellating her, etc. When awake she was sullen and surly. Another case mentioned in the same pages is that of a lady twenty-three years of age, in perfect health, who on the night before the day on which she had promised to witness a painful surgical operation performed upon a dear friend, went to bed with her fears and imagination so highly excited that convulsions and hysterics supervened, followed by a profound sleep which continued sixty-three hours. Several of the most eminent physicians of the day being called in consultation she was cupped. This awoke her, but the hysterical and convulsive effects returned, followed again by a long sleep which, with some few short intermissions, lasted a fortnight. After this she slept as naturally as before for twelve months, and then, with no apparent cause, the extraordinary long periods of sleep returned, and continued irregularly for ten or twelve years, the periods of each sleep varying from thirty to forty hours, but steadily diminishing until she was again well and slept naturally. Following her recovery came restlessness and irritability, followed by three months of total sleeplessness ending in madness. After the expiration of precisely six months the long sleeping fits returned, but were regular in their coming, and their duration, each generally lasting forty-eight hours and always beginning a few minutes after midnight. Her reason had then returned. She had a great horror of attempting to keep herself awake.

Another case resembling the above is the better-known one of Elizabeth Perkins, who lived at Morley St. Peter in Norfolk. She at first only awoke for one day in every seven, but after a considerable time the periods of sleep became irregular and precarious, and although shorter in duration, were, while they lasted, equally profound, defying all attempts either to keep her awake at first or to awaken her afterwards. Various experiments were vainly tried, and on one occasion an itinerant quack who was consulted pronounced the sleep a counterfeit one, and the patient a prodigy of obstinacy instead of sleepiness. However, the rascal professed ability to work a cure, whether it was real or false, and blew into the poor creature's nostrils the powder of white hellebore, which is a terribly strong stimulant. His patient remained insensible to the inhumanity of the act, which dreadfully excoriated the skin of her nose, lips, and face.

There is in the British Museum, amongst the rare pamphlets preserved there, one giving an account of "The sleepy man awakened of his five days' dream; being a most strange and wonderful true account of one Nicholas Heart, a Dutchman, a patient of St. Bartholomew's Hospital in West Smithfield, who sleeps five days every August. The title-page goes on to declare, in the curious fashion of those days, how the lad's mother on the first of August fell asleep for five days immediately before his birth, which wakened her; and then proceeds to narrate of him the fact that "as soon as he was born he sleeped for five days and five nights; together with the true dream which he and his mother dreamt every year alike. But what is more particular than all the rest, he gives an account of one Mr. William Morgan, who he saw hurried to a dismal, dark, castle; and one Mr. John Palmer; he saw him going into a place of bliss (these two men were patients in the hospital, and dyed while in his sleep)."

Amongst numerous records of such remarkable sleeping, ancient and modern, are that mentioned by Platerus of one who slept soundly through three successive days and nights; that mentioned by Aristotle of a nurse who every year would hide herself away in some place, where she fell into a deep sleep, which continued two months; and the young scholar of Lubeck mentioned by Crantius as one who, in the time of Pope Gregory XI., hid himself in a box behind a wall to sleep, and was found in it, still asleep, seven years after, long after it had been believed that he had gone away to his own country. On being awakened the young man said it seemed to him that he had slept but one night and part of the day. This case may easily have been a mere hoax. Marcus Damascenus mentions a German rustic who went to sleep under a hay-rick, and being very weary, did not wake all through the following autumn and winter; and Pliny has told us how Epimenides, the Gnossian or Cretan boy, being hot and weary, went to sleep in a cavern and remained asleep for fifty-seven years! He seems to have been the original Rip Van Winkle; for returning home to his native village, he was terribly perplexed by the wonderful changes wrought there, and by recognising his little baby brother in a feeble old man. The old-world proverb concerning the sleep of Epimenides came from him. We need hardly add to these ancient prodigies that of the Seven Sleepers of Ephesus, whose story is so well known; but the case mentioned by King Henry III., to which that monarch was an eye-witness in Poland when with other princes and noble personages, may not be so familiar. According to this, as quoted in credulous old Wanley's "Wonders," the inhabitants of Lukomoria sleep through their intensely cold winters "after the manner of swallows and frogs." Fernelius speaks of one who was mad and who slept for fourteen months.

In the reign of Henry VIII., a pot-maker named William Foxley fell asleep on Tuesday in Easter week, says Wanley, "and could not be awakened with pinching or burning, till the first day of the next term, which was full fourteen days; and when he was then awakened he was found in all points as if he had slept one night."

A REMARKABLE SILVER MINE.

In the sixteenth century an Indian peasant was pursuing wild goats up the sides of the Cerro de Potosi, a mountain in Bolivia, South America, a little over 16,000 feet high. Coming to a more than ordinarily steep place, he laid hold of a shrub while climbing, to prevent himself from falling. The shrub gave way, and Diego Hualca fell; but in falling, his quick eyes took note of the fact that in uprooting the shrub he had laid bare a rich mass of silver. The discovery was not long in oozing out, and in 1545 mining operations were commenced. The Spaniards were quick to take advantage of this new source of wealth, and a city reared its head in close proximity to the mines on the mountain-side, with a population of adventurers which in about fifty years from the discovery numbered 160,000.

The Cerro de Potosi is now perfectly honeycombed, having, it is said, no less than 5,000 openings into it. The value of the silver which has been obtained from it since 1556 is nearly £250,000,000 sterling. The mines are now nearly exhausted, and the town of Potosi only contains about 23,000 inhabitants. Its main source of wealth has gone, and the town generally has now a ruinous aspect.

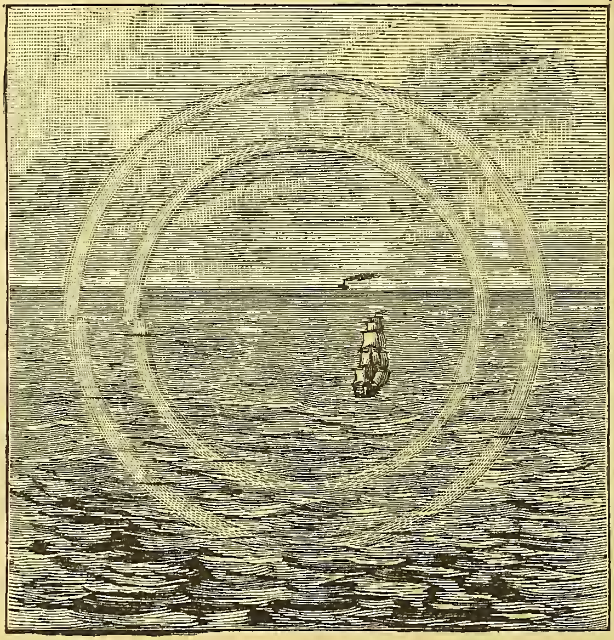
A Wedding in the Air.—At five o'clock in the afternoon of October 19th, 1874, an immense concourse of people assembled in the city of Cincinnati, Ohio, to witness the ascent of a bride and bridegroom in a balloon to be married in the air by a clergyman who ascended with them, and delivered an address to the crowd before the machine was set free. The couple were horse-riders in a circus, and the idea was, no doubt, that of combining business with pleasure, since hundreds would be curious to see them in the circus after their marriage, who, before that remarkable event took place would only regard them with the ordinary amount of curiosity due to their skill as riders.

WONDERFUL RAINBOWS.

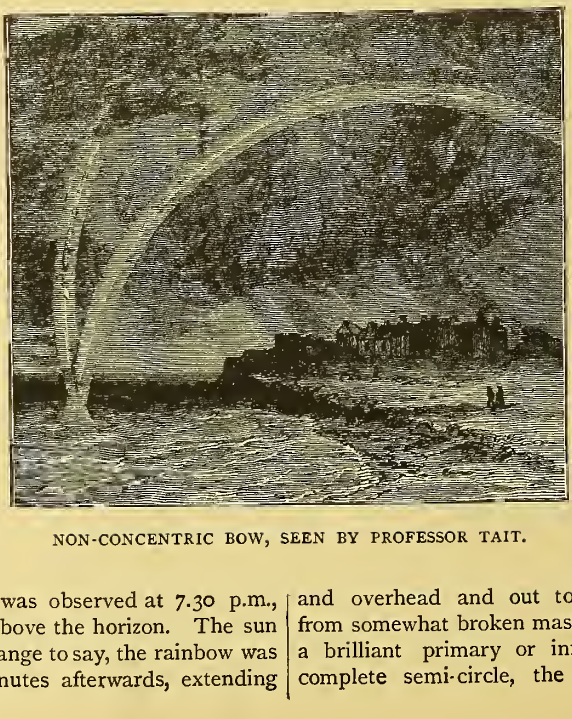
A RAINBOW with neither sun nor moon visible; a bow stretching across between the two usual bows and connecting them; and the image of an unseen rainbow in the water, are such very unusual appearances that one may call them wonderful on account of their rarity alone, for it is seldom given to a man to see such sights more than once in his lifetime.

We shall confine ourselves here to a brief description of these wonderful rainbows, thus making up in a poor way for the want of a sight of them, which most of us will have to submit to, and we may also, in passing, point out the surprising features of each case.

To see an ordinary rainbow, either solar or lunar, the light of the sun or moon is required, and one or other of these sources of light mostly occupies a prominent position in the heavens at the time. It is not a little curious, therefore, to hear of a rainbow produced by the sun's light after that luminary had set. Such a phenomenon was seen at Whitby, on the 11th of August, 1855, by Mr. C. P. Knight. On this day a rainbow was observed at 7.30 p.m., while the sun was yet above the horizon. The sun set at 7.44 p.m., but, strange to say, the rainbow was visible for full four minutes afterwards, extending higher than some cirro stratus clouds which were seen in front of it.



REFLECTED RAINBOW.

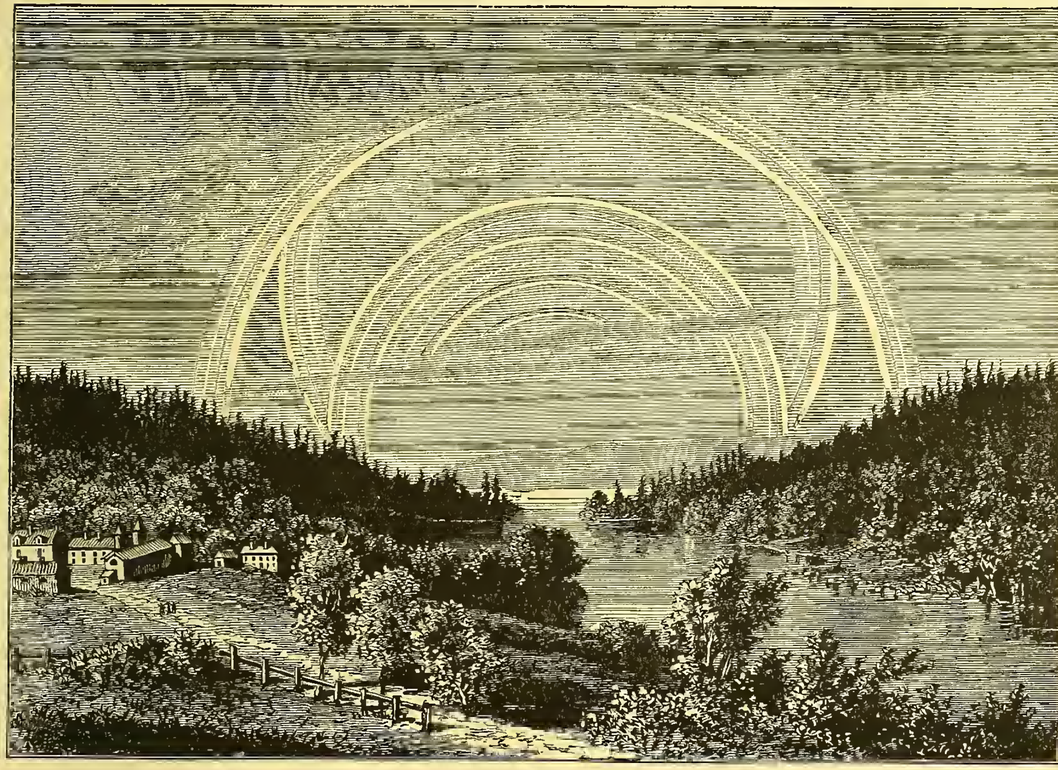


NON-CONCENTRIC BOW, SEEN BY PROFESSOR TAIT.

More interesting is the case of reflected bows, inasmuch as Science, which at times criticises its sister, Art, has found fault with the way in which reflected rainbows have often been represented on canvas. What these images in the water are like, will be apparent from a perusal of a minute account of a few observations. On February 2, 1874, Mr. George Dawson saw a reflected bow at Balbriggan in Ireland. The two legs of the aërial bow seemed but a few hundred yards from the observer, and a reflection of a bow was seen in the water. The latter was evidently not an image of the bow in the air, as the two bows were not feet to feet. The reflected bow appeared to be lying *inside* the other, the red of the one commencing where the violet rays of the other disappeared. Mr. Wm. Crookes, the physicist, has recorded a somewhat similar observation, made on August 6, 1877. He was standing at the end of Eastbourne Pier looking towards the sea. Behind him the sun was low on the horizon, but shining brightly, and overhead and out to sea rain was falling from somewhat broken masses of clouds. In front a brilliant primary or inner rainbow formed a complete semi-circle, the two ends apparently resting on the sea, and outside this there was a secondary or outer bow shining with considerable intensity. The sea was calm, but its surface was by no means glassy, being ruffled over with minute wavelets. Reflected from the surface of the sea, and extending in a broken curved line from the extremities of the rainbows nearly up to the pier, there was an apparent complete reproduction of the colours in the sky. That it was not really a case of reflection of the aërial bows was evident from the fact here again seen, that the feet of the primary and secondary bows in the air did not correspond completely with the feet of the primary and secondary bow images in the water. The diameter of the reflected bows seemed less than those of the aërial bows.

Mr. Robert Sabine, commenting subsequently on the foregoing observations, showed how it was possible to obtain reflected bows artificially, and remarked that those reflected bows he saw were always apparently smaller in diameter than the real bows which were visible at the same time from the same position.

Another observation of a reflected bow made by the late Professor Stanley Jevons is worthy of mention here. In 1880, while proceeding up one of the lower and broader reaches of the Hardanger Fiord on a steamboat, he saw a bright reflected rainbow without the usual prismatic colours. The water was almost tranquil, and a brilliant aërial bow appeared upon a heavy shower of rain which was falling on the farther side of the fiord. The image seen in the water was a very peculiar one, for it was whitish, and consisted of a broad and nearly straight streak of confused light extending from the base of one side of the bow to within twenty yards of the steamer, where the reflection rather suddenly curved off in an awkward, sickle-like form, and was soon abruptly lost. The whitish colour of this reflection was due to the minute ripples on the surface of the water causing an over-lapping of the colours and therefore a mixture of them before they reached the eye. Shortly before his unfortunate death, Professor Jevons saw a reflected rainbow under more perfect conditions. He was standing on the flat wet sands of the sea-shore, when he observed the image of a rainbow on the wet sands almost perfect both as regards form and colour. In passing we may remark, that an artist unacquainted with the science of the matter would be disposed to make the feet of the aërial bow correspond with the feet of the reflection, just as he makes



NON-CONCENTRIC AND EXTRA BOWS SEEN AT NYA, SWEDEN, IN 1875.

the feet of a bridge correspond with those of the reflected bridge in the water. The two cases are, however, entirely different, and it will suffice for us to say here, that when a reflected bow is seen, its feet do not correspond with the feet of an aërial bow the same observer may see at the time. To put it in another way, if a person sees a rainbow it is impossible for him to see the image of the self-same bow reflected in the water. Herein lies the marvel of the observations we have described. The extreme rarity of the phenomena arises from there being such a conjuncture of circumstances required before a reflection can be seen; for the observer must be in a suitable position with regard to the reflecting surface, there must be a brilliant sun, and a tranquil sheet of water.

The same combination of conditions is required before one can see the remarkable non-concentric bows which we shall next describe. It is a curious fact in connection with such non-concentric bows, that when they are seen the sun is generally at a very low altitude, as a rule not more than ten degrees above the horizon. The slanting rays of the sun being then reflected from the water in great quantity, produce rainbows higher up in the heavens than those that are made by the sun's direct rays, and the two systems of bows, those produced by the direct rays and those produced by the reflected rays, consequently intersect each other. The complete non-concentric bow is seldom seen, for it is requisite the observer should have a calm reflecting surface of water extending in front, around, and behind him. But as an observer is generally standing on land with a river or arm of the sea behind, before, or to one side of him, only a fragment of a bow is seen, the particular part observed depending of course upon the position of the reflecting surface. A fragmentary bow was seen on September 11th, 1874, by Professor Tait, at St. Andrews. The reflecting surface was to the left of the observer, and for some distance nearly parallel to the direction of the sun's rays, and consequently there was only one leg of the non-concentric bow seen, and that was the left one.

Non-concentric bows have been seen at various times during the last two hundred years. One of the most perfect was observed by Halley, the astronomer, on August 6th, 1698, between six and seven p.m., as he was standing by the Dee. It appears to have been a very perfect specimen of a non-concentric bow, extending in an unbroken arch from the feet of the inner bow to the summit of the outer or secondary bow. The order of colours in this non-concentric bow was the same as in the primary; so that where it appeared to overlap the secondary bow there was a portion of a white arch. Dr. Sturges saw the fragments of two non-concentric bows off Alverstoke, on the sea-coast of Hampshire, July 9th, 1792. Both fragments sprang from the right legs of the usual inner and outer bows, and their lengths were very evidently limited by the extent of sea-surface reflecting the sun's rays. Perhaps one of the most remarkable cases is that represented in our third illustration, in which it will be noted that between the ordinary inner and outer bows there are the legs of a bow non-concentric with both. This splendid sight was seen at Nya, Kopparberg, in Sweden, by M. Gumœlius, on June 19th, 1875, and it is remarkable that similar bows have been recorded in Sweden on several occasions. In this case, besides the non-concentric bow, several supplementary concentric bows were seen, as shown in the engraving.

A fragment of a very curious non-concentric bow was seen in 1665 at Chartres by M. Estienne. The

BOW SEEN BY M. ESTIENNE.

sun was about six degrees above the horizon, and there was the river close by, which was presumably the reflecting surface. The curious feature of this observation was that the fragment of non-concentric bow is described as not springing from either foot of the primary, their relative positions being as in the annexed engraving.

Other wonderful rainbows, or perhaps more correctly, *mist-bows*, have been seen on rare occasions. Aëronauts and mountaineers have observed them of a completely circular form, when they have happened to be in elevated positions. A somewhat similar phenomenon is sometimes observed by the boatmen of Lake Superior when there is a low-lying fog on the water, and a brilliant sun overhead. On such occasions an iridescent halo surrounds the shadow of the observer's head, but is generally of a simply circular form.

A very remarkable mist-bow or fog-bow of this sort was witnessed by Mr. Edward Whymper, in descending the Matterhorn, immediately after the disastrous accident which signalised his first ascent in 1865, and is figured as well as described in his work: in this case the circular bows were accompanied by straight, perpendicular, iridescent lines, which appeared by their intersections with the bows to produce figures in the form of a cross. These modifications have several times been seen in fog-bows.

FISH AND FROG PARENTS.

A HIGH authority on all matters relating to the structure and history of fishes relates that "instances of the female taking care of her progeny are extremely scarce in fishes." On the other hand, cases in which the *male* fish attends to the wants and cares of the offspring are tolerably common. Only two examples are known in which the mother fishes tend their young. These instances are seen in the fishes known to naturalists under the names *Aspredo* and *Solenostoma*. The former fishes belong to the group known familiarly as "Cat Fishes." Their habitat is Guiana, and the peculiarity observable in their care of the young is not only in itself remarkable, but is also allied in some degree to the similar care exhibited by certain species of the frog class, to be hereafter noted. When the time of egg-laying approaches, the skin on the lower surface of the *Aspredo* becomes soft, and assumes a spongy consistence. The eggs are deposited in this soft skin after they have been laid, by the mother-fish pressing upon them. Here the young are carried during the whole period of hatching. When they are fully developed, they escape from the maternal integuments, and the skin of the parent resumes its normal condition. The second example of the care of the offspring by the mother-fish occurs in the group *Solenostoma*, which, curiously enough, belongs to a division of fishes including the Sea Horses (*Hippocampi*) and Pipe Fishes (*Syngnathidæ*), in which the *males* attend to the interests of the young. These fishes occur in the Indian Ocean. The cradle for the young in this case is formed by the two *ventral* or "belly fins," which at the proper season unite with the skin of the body so as to form a long and capacious pouch. In this pouch the eggs are contained and hatched; and it would further appear that within this pouch there are developed long thread-like processes, which spring from the fins in question. The use of these threads appears to be that of the attachment of the eggs, and possibly some nutritive function may be also discharged by these organs. It is evident, at any rate, that in such fishes a special provision is made for the welfare of the young: and this of a character even more perfect and pronounced than is seen in the previous example. That it should be so in one of the rare cases of maternal care is very interesting.

The care of the offspring in fishes by the males finds ample illustration in the groups of the Sea Horses and Pipe Fishes already mentioned. The Sea Horses are well known as denizens of our aquaria; their heads curiously resembling those of horses in shape, and the lithe bodies swimming upright in the water, together with the flexible tail, constitute a combination of characters more than sufficient to arrest attention. The male Sea Horse possesses a pouch on the under surface of his body, in which the eggs are hatched, and in which the young reside for some time. There appears to be a strong attachment between the parent and the young, for it has been related that the young swim in and out of the pouch, and that when the parent has been captured and held over the side of the boat, the young, which had previously escaped into the water, again entered the pouch.

The Pipe Fishes—so named from their elongated jaws, which form a pipe-like snout—possess a pouch similar in its nature to that of the Sea Horses. An American naturalist, Mr. Lockwood, is of opinion that in addition to its function of protecting the young, the pouch in the Sea Horses also discharges a nutritive function. He believes, as the result of observations made in the development of these fishes, that the inside of the pouch affords nourishment in some way to the young. If this observation should prove to be correct, it will place the Sea Horses in a still nearer relationship to those quadrupeds which, like the Kangaroos, protect their young within a pouch, and also nourish them whilst so protected.

More extraordinary still, in respect of the peculiarities of parental habits, are the cases of those fishes which carry the eggs, and hatch them, *within their mouths*. Certain fishes belonging to the genus *Arius*, for example, illustrate this habit, these fishes being allied to the "Cat Fishes." The eggs are carried about by the fishes in their mouths, and appear to be safely lodged during the period of hatching in the large and capacious *pharynx*, or hinder part of the mouth-cavity.

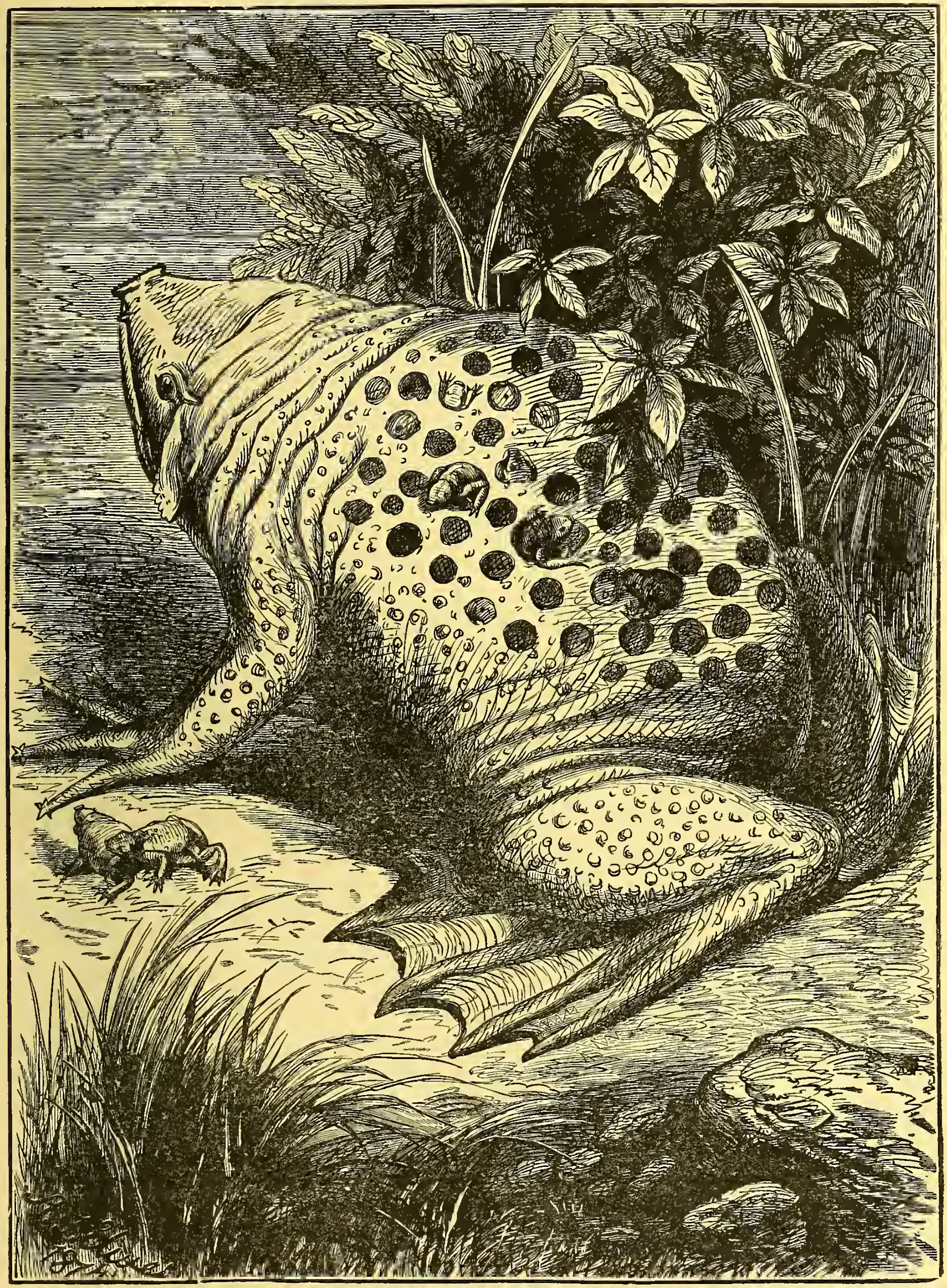
Another well-known instance of a like habit is furnished by the fishes of the genus *Chromis*, from the Sea of Galilee. These fishes in the same way carry the eggs in their mouths, and thus hatch the young; and it is interesting to note that a similar or analogous practice is witnessed in certain frogs, to be presently described.

Within the class of the frogs, toads, and newts, or that of the *Amphibia*, we discover still better marked cases, in which the young are protected in fashions at once curious and interesting. The case of the fish *Aspredo*, for instance, is almost exactly paralleled by that of a curious toad found in Surinam, and named accordingly the Surinam Toad, or *Pipa Americana*. It is the female frog which assumes parental duties, and at the breeding season the skin of the back becomes of soft and spongy texture. The male frog takes the eggs which have been laid by the mother frog, and presses them into the spongy skin of her back, so that each egg becomes imbedded within a little extemporised cavity of the skin. Here the eggs undergo development. The tadpole stage, which, as all readers know, is passed outside the egg, and in the ponds and pools in the case of the common frog and others of its race, is passed within the egg in the case of the Surinam Toad. The young toads in due course emerge from the cells in their mother's back, fully developed in every respect save size. It is stated that over 120 eggs of eggs are seized by the male frog, who twines them round his thighs, and retires into some shady nook. Here he remains until the period arrives at which the young frogs are destined to escape from the egg; then the parent plunges into the water, into which the young frogs escape, to undergo their

SEA HORSES (*Hippocampi*) AND YOUNG.

have been counted in the back of a single Surinam Toad.

A frog quite common on the Continent of Europe, and known as the *Alytes obstetricans*, illustrates another phase of parental anxiety, as represented in the amphibious class. Here the female deposits the eggs in long strings, united to one another by the gelatinous outer covering of the eggs. These chains further development. One of the little Tree Frogs possesses the habit of laying its eggs in the angles between the leaves of trees and the branches on which they are borne. Here the eggs, which, like those of most other Amphibia, appear to demand a supply of water for their due development, obtain such supply from the water-drops that find a lodgment in the leaf-angles. The existence of this



FEMALE SURINAM TOAD (*Pipa Americana*).

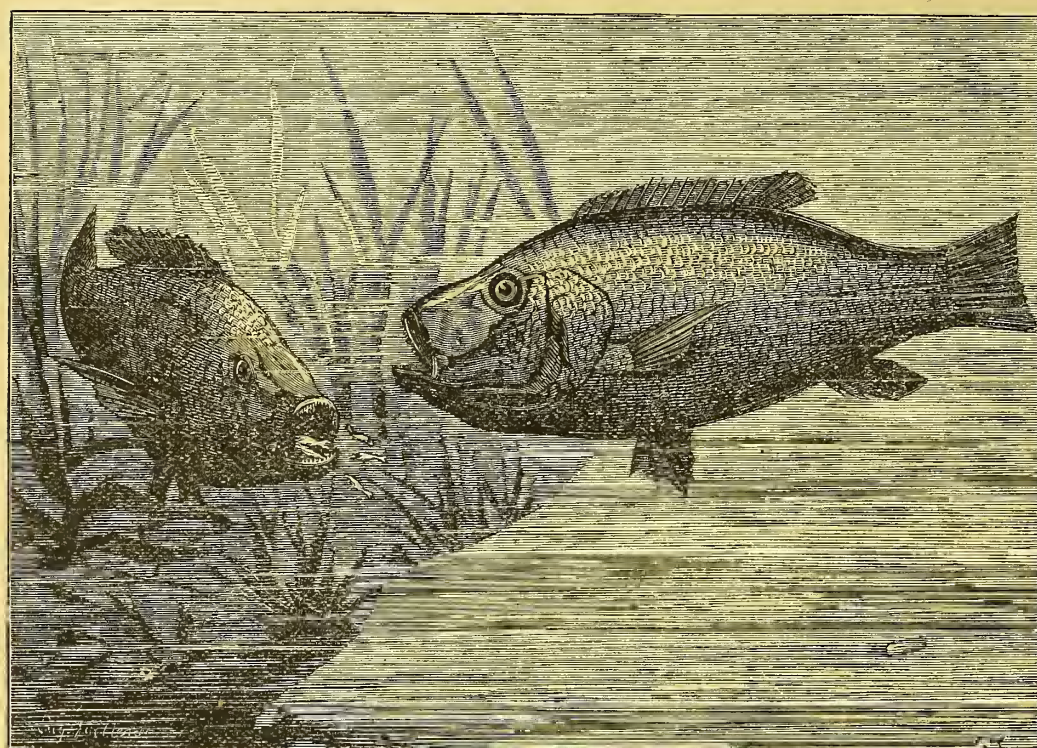
SHOWING CELLS IN THE BACK.

habit serves to show how material may be the alteration in its mode of life which an animal whose eggs are normally deposited in water may undergo.

One of the most singular cases in which parental duties are discharged by the frog and toad group is seen in the American Tree Frog, known to naturalists as *Nototrema marsupiatum.* Here a pouch extends over the back surface, and possesses a hinder opening. The eggs are placed in this pouch, and are therein protected. But leading us to still more curious developments of the parental

But these sacs, it appears, have become diverted from their original function to subserve a widely different use. Instead of participating in the modification and intensification of the voice, they have become utilised as "brood pouches." Into the "vocal sacs" of the males—which, indeed, alone possess them—the eggs are introduced; there they are protected and undergo development, and within them the young are kept until they can forage for themselves.

That the vocal sacs of the Rhinoderma in their



CHROMIS PATERFAMILIAS AND YOUNG.

habit, we find in a little frog found in Chili a modification surpassing any of the preceding features in interest. This frog is named the *Rhinoderma Darwinii.* Like the common edible frog (*Rana esculenta*) of Europe, this Chilian frog possesses in the male two *vocal sacs.* These latter are two sacs, or bags, situated in the mouth, and which appear to aid in increasing the resonance of the voice. They thus increase the loudness of the "croak," and are in this way analogous to the "voice sacs" of certain of the American monkeys, such as the Howlers, whose voice resounds for miles through the forests of the New World. The Rhinoderma possesses a clear, and almost musical croak, testifying to the utility of the vocal sacs.

original nature were small in size cannot be doubted; but in the frog as it at present exists they have become greatly enlarged. Instead of existing merely as simple sacs, confined to the mouth of the animal, they are found to extend beyond the chin, and onwards to the body of the animal, uniting in the middle of the abdomen. Within each of these sacs one observer found from five to fifteen young in the tadpole stage of development. The smallest and least developed of these young were found at the bottom of the sacs; and it would appear that in their development the tadpoles of Rhinoderma exhibit a somewhat shortened and abbreviated life history, as compared with that of other frogs. But the comparatively new use to which the vocal sacs of this frog have been put has not been without its due effect on the structure and organisation of the animal. We find that the tongue is remarkably shortened, and that even the bones of the shoulder have become compressed and altered, so as to make way for the enlarged vocal sacs when these contain their full complement of progeny. The internal organs of the frog are also much displaced, especially when the sacs are distended with young; and it would thus seem as if the whole organisation of the animal were modified to give due effect to the singular provision which Nature has in this case made for the perpetuation of the race.

CURIOUS PRESS BLUNDERS.

MAX ADELER described an angry poet whose verses on "The Surcease of Sorrow" contained this line:

"Take away the jingling money; it is only glittering dross."

which the blundering printer converted into—

"Take away thy jeering monkey, on a sorely-glandered hoss."

and also another line—

I am weary of the tossing of the ocean as it heaves."

which appeared in type as—

"I am wearing out my trowsers till they're open at the knees."

Extravagant as these fictitious errors may be, actual blunders have been perpetrated which are hardly less so. At the time when Mr. Gladstone, our present Prime Minister, was making many speeches, the compositor made one of his greatest admirers speak of him as the "spout" of the Liberal party instead of its "spirit." A report of the number of children born alive in a certain hospital not long since figured in print as children "burned alive" in it. Not long since Mr. W. E. Forster made a speech at Bradford in which, instead of denouncing, he was made to advocate secular education at the Board schools, by the printers' omitting the little word "not." Lord John Manners was once made by a similar blunder to recommend starving agricultural labourers, instead of yeomen farmers, to employ their enforced leisure in fox-hunting! In like way Sir William Harcourt accused Sir Robert Peel, in type, of sitting at the feet of the "Gamebird" instead of the "Gamaliel" of Birmingham. The *Daily Telegraph*, at the time of the Russian War, stated that a certain district had been placed under "marital" instead of martial law; and some time after another morning paper astounded not a few by saying that the Lord Chancellor was "less accustomed to palsy and fever" than the Prime Minister was, the words of the writer being "parry and tierce." A provincial paper, some time since, told how a railway train had knocked down a cow, and cut it, not into halves, but into "calves." In one edition of Cowper's Memoirs, "Montesquieu" figures as "Mules Quince." In a New York paper we find "the brass hoppers used in coffee-mills" converted by a blunder into "the grasshoppers used in coffee-mills." In an old copy of the *Evangelical Observer* a writer who said he was *rectus in ecclesia*, that is, of good standing in the church, was made to say he was *rectus in culina*, of good standing in the kitchen. *The Eclectic Review* once appeared in an advertisement as *The Epileptic Review*, which somebody explained as a new publication which was coming out in "fits and starts." In a leader on the Irish Obstructionists, *The Times*, speaking of a sitting in Parliament which lasted from "four in the afternoon till six in the morning," said "if it be asked what passed in this long interval, the answer must be twenty-six (!) hours." Another London paper, instead of saying a lady died of hæmorrhage, informed the public that she died of her marriage. Mr. E. A. Freeman was once spoken of as "a man who had gained real distinction as a barbarian" instead of historian, and the same paper described Mr. Gladstone as addressing not a "noisy mob" but "a noisy snob." A writer who wrote of nature's works as "silent preachers of morality," found them in print "preachers of immorality," and on another occasion the table decorations at a fashionable wedding were described as "pot-house" instead of "hot-house."

CONTENTS OF A COTTON-POD.

BY sundry operations of ginning, scutching, spinning, &c., the white fibrous contents of the cotton-pod are worked up into a variety of useful textile articles; and these contents are as wonderful in their way as the uses to which they are ultimately put. So fine are the cotton-fibres, that one grain weight of American cotton will contain from 14,000 to 20,000 individual filaments: in other words, the average weight of one of these cotton hairs is only $\frac{1}{17000}$th part of a grain; and it has been calculated that if the filaments in 11 lbs. of cotton were placed end to end, they would form a ring stretching all round the earth.

The cotton-fibres consist of a substance which chemists call cellulose, which may be worked up into other materials besides textile fabrics. Paper is often made from cotton rags. The cellulose may also be made to undergo some wonderful changes by means of chemical re-agents. Thus a proper strength of sulphuric acid will convert a sheet of unsized paper into parchment paper (papyrin), and cotton wool is converted into gun-cotton, a highly explosive substance, by steeping it in a proper mixture of nitric acid and sulphuric acid.

THE AMERICAN MOUND-BUILDERS.

PRIMITIVE as were the habits and customs of the inhabitants of America at the time of its discovery by the Europeans, yet the researches of American archæologists have shown that some considerable portions of the northern continent had, in prehistoric ages, been occupied by a race of men who had arrived at a comparatively high state of civilisation. The Aztecs of Mexico are already well known to most readers. But a race of semi-civilised people, possessing, if possible, even more interest than these, at one time occupied an immense tract of land to the north of the Aztec settlements. These were the people known to us only as "Mound-builders," the remains of whose settlements and works are met with throughout the western part of the United States. The monuments of these early inhabitants occupy the entire area of the great Mississippi Valley and its tributaries, and the fertile plains extending along the Gulf of Mexico.

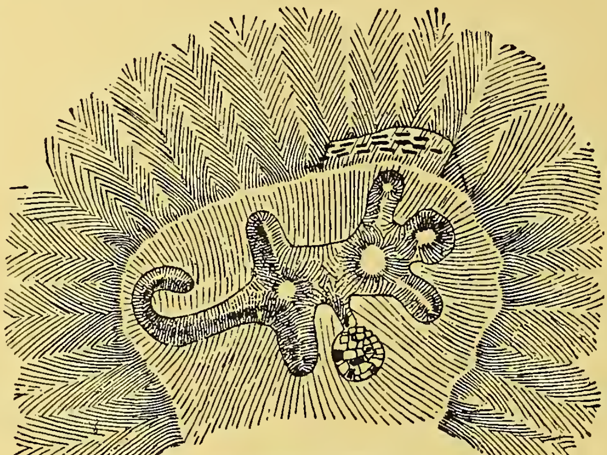


Fig. 1.—ALLIGATOR-MOUND IN MISSISSIPPI VALLEY.

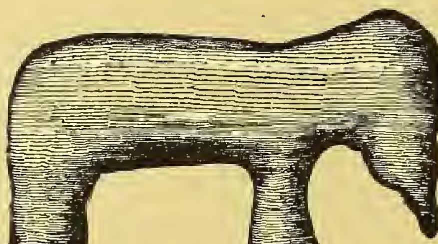


Fig. 2.—ELEPHANT-MOUND.

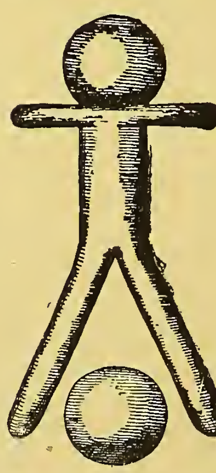


Fig. 3.—MOUND IN WISCONSIN.

It is in the north-west, chiefly in Wisconsin, that the most extraordinary and incomprehensible of the mounds occur. They are frequently in the form of various animals and of human beings. They are invariably erected upon level plains, and generally consist of homogeneous sand or earth, which in most cases, if not in all, cannot be distinguished from the surrounding soil. They are raised above the plain upon which they are erected sometimes not much more than a foot, sometimes as much as six feet, and where they have remained undisturbed present a regular and well-marked outline. As, however, they have often a length of from one to five hundred feet, it is not always possible to recognise the form of the mound until it has been carefully surveyed, and laid out upon paper on a small scale. Animals of all sorts found upon the great American prairies; bears, panthers, turtles, alligators (Fig. 1), snakes, deer, and many others, are seen in immense basso-relievos—the monuments of a people who have long since passed away; and it is remarkable that amongst other forms are found that of the extinct mammoth elephant (Fig. 2), or, as some think, the mastodon, and of man himself (Fig. 3). From the forms adopted in the construction of these mounds, and from the fact that human bones have occasionally been found buried in their midst, it has been suggested that they were originally erected as places of sepulture by the different Indian tribes, who are known to use various animals as their characteristic *totems*, or tribal ensigns. But were this really the case, how extraordinary would be the degeneracy of their present descendants! The erection of these huge mounds in definite and more or less artistic forms implies a large degree of knowledge of mensuration and surveying, as well as a large and steady supply of labour; which could never have been at the command of savages dependent, as most of the North American tribes until recently were, upon the chase for their means of subsistence. Nor have the existing tribes any sort of tradition regarding the erection of these ancient monuments, but look upon them with simple reverence, as the work of the "*Great Manitou*."

Interspersed amongst the "animal" mounds are some of those tumuli which occur in great abundance, unaccompanied by the more strange animal forms, in the southern region of the Mound-builders. It is curious to observe that these tumuli, which are generally circular, are almost always much higher than the surrounding mounds (Fig. 4), and that from their summits may generally be obtained a view of the entire group of earthworks with which they are connected. Some of these tumuli were undoubtedly used as places of sepulture, but in others not the slightest traces of human remains have been found, and we are therefore led to the belief that these higher elevations were used as towers of observation. As we proceed towards the south, the "animal" mounds disappear. In their place, we find works the use of which seems far more easy of explanation. These are immense "enclosures," which were sometimes erected for the defence of the settlements, sometimes, doubtless, for the protection of sacred works. The defensive enclosures are generally situated upon sites which are naturally strategically strong. Often a rocky hill surrounded at its base by some deep and winding stream has been selected for the erection of the fortifications, and in every case some natural advantage in the formation of the land surface has been seized upon for the combined purposes of saving labour in the erection of works of defence, and of attaining the greatest possible security from attack. The walls of these enclosures sometimes circumscribe an area of as much as 140 or 150 acres, though they are frequently of much smaller extent, and the enclosed settlement often stood upon an area of twenty or thirty acres. The walls were built of large irregular blocks of stone, but probably were never cemented together, and have now fallen into complete ruin, though occasionally indications have been met with tending to prove that the walls were regularly faced, at least on the exterior. "The appearance of the line," in the case of the works surveyed near Bourneville, in Ohio, "for the most part, is just what might be expected from the *falling outwards* of a wall of stones placed, as this was, upon the declivity of a hill." When these enclosures have been erected upon steep elevations, a more gentle slope will, as a rule, be discovered at one, or sometimes more points, by which an easy approach could be made from the outside. These slopes were, however, always protected by a strong enclosing wall, having two or three narrow passages only, for ingress and egress, and often a strong outer barrier of stones or earth was also erected, which must have added greatly to the security of the defenders in case of attack. Some idea of the enormous labour of erecting these fortifications may be gathered from the fact that in one case the enclosing wall measured no less than 8,224 feet in length, and rested on a base measuring from thirty-five to forty feet. The height varied considerably ; it was sometimes from six to ten feet, and occasionally reached as much as fifteen feet.

Fig. 4.—TUMULUS IN OHIO.

Within the wall was a ditch, having an average width of no less than fifty feet, and it was doubtless of the earth and sandstone excavated in its formation that the enclosing wall was constructed. When it is considered what would be the labour of constructing defences such as this, even with the appliances now at our command, we are filled with amazement that a primitive people, unacquainted with the use of any metal except native copper, should yet have possessed the power, the will, and the unity necessary for their erection.

Another class of enclosures, which it is obvious could never have been erected for defensive purposes, have been regarded — no doubt, justly — as sacred enclosures, although their use has not been, and probably never will be, definitely settled.

It is interesting to observe that in these enclosures the forms of the circle and square predominate, and these two figures are frequently met with together, and in such a connection that there can be no doubt they were employed symbolically (Fig. 5). In place of the square, however, an octagon is frequently met with, and these two—the circular and rectangular enclosures—are generally connected by a narrow passage, enclosed on either side by a wall or embankment. Unlike the defensive works, these sacred enclosures are found generally upon perfectly level plains, and sometimes occur within other enclosures of quite a different character. Their walls were often of the most massive construction, and were occasionally as much as twelve feet high, with a base of no less than fifty feet. Where the enclosures take the form of squares and circles, it is worthy of remark that these are found by the most careful surveys to be absolutely geometrical figures, proving how advanced must have been the knowledge of the Mound-builders in mathematical science.

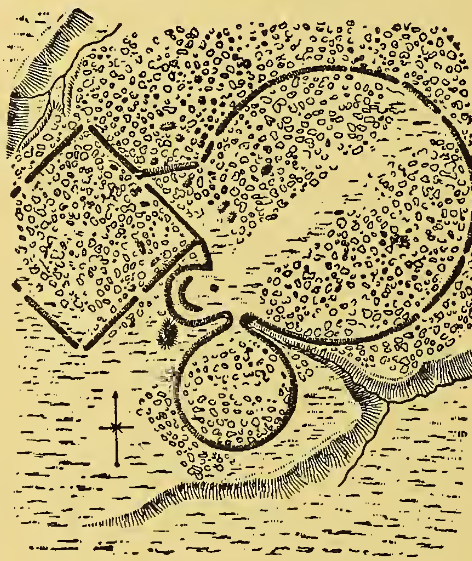


Fig. 5.—ENCLOSURE IN OHIO.

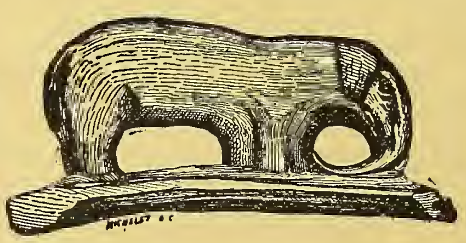


Fig. 6.—ELEPHANT ON PIPE FOUND IN IOWA.

Within, and in the vicinity of, both sacred and defensive enclosures, innumerable mounds, or tumuli, are met with. Some of these were used as altars, and it has been supposed that the religion of the Mound-builders was, in part at least, connected with the worship of the sun and of fire; of this, however, it cannot be said that there is any absolute proof. Other of the mounds, sometimes as much as eighty feet in height, were doubtless used as points of observation, and others, again, were the tombs of important individuals amongst the community, possibly of the priests, who are also supposed to have been the patriarchs and governors of the Mound-builders. In the sacrificial mounds are found symmetrical altars of burnt clay or stone, and on these are often deposited various remains, always bearing unquestionable traces of having been subjected to the action of fire.

Many specimens of primitive art have been taken from both the sepulchral and sacrificial mounds, and some of these possess great merit, even from an æsthetic point of view. They consist of vessels of clay and of implements of various kinds, of stone, flint, and copper; ornaments of these minerals and also of silver have, too, been frequently met with, and a large number of pipes, often very powerfully carved, have been figured and described. The elephant on a pipe (Fig. 6) may be compared with the mound shown in Fig. 2. The sculptures of the Mound-builders show, indeed, more than anything else the degree of culture to which they had attained, and we cannot but be surprised that a people once so highly civilised should either have become utterly extinct, or should be now represented by those Red Indians whose few good qualities have been so extolled by Fenimore Cooper and his imitators.

That an immense space of time must have elapsed since the Mound-builders ceased their labours in the Mississippi Valley it is easy to affirm; but to calculate this lapse of time in years is a far more serious undertaking. Much has been argued from the now extinct mammoth being represented both in mound and sculpture, but this argument cuts both ways, and it is quite as possible that the mammoth has rather survived to a more recent date than has been supposed. We find here and there that the ancient earthworks have in part been eaten away by the gradual change in the course of neighbouring streams—a change which in some cases extends to many hundreds of feet. But to calculate the annual rate at which the river has thus encroached upon its bank is difficult in the extreme; nor can we be sure that the encroachment has been always regular, and always in precisely the same direction. Growing upon most of the enclosures and other works, if not upon them all, we find, however, a dense forest jungle, and the ages of the trees forming this forest may of course be approximately arrived at by counting the number of annual rings of growth. By this means it has been ascertained that some of the trees growing upon the mounds, or in the midst of the now ruined walls or embankments, must have an age of at least 700 years, while the trunks of other trees still lie in a mouldering state at their base, which from their size must have had an equal antiquity, and would throw back still farther the age of the works. No trace is now met with amongst the luxuriant vegetation of the Mississippi Valley of the remains of cultivated plants. These were doubtless overgrown and replaced, ere many years had passed, by a rank and heavy growth of reeds and grasses, which in their place must gradually, and as we know from experience in the tropics in similar cases, very slowly, have been supplanted by the forests which now cover the whole of the country. When we consider, therefore, the time which must have elapsed before the once cleared and cultivated land of the enclosures could have become covered with a dense forest, in no way distinguishable from that primæval forest which we have no reason to believe has ever been disturbed by man, the probable antiquity of these pre-historic settlements becomes more and more remote, so that the estimate of 1,500 years made by Messrs. Squier and Davis may justly be deemed within rather than without the mark.

VAGRANT NEEDLES.

AMONG the curiosities of surgical literature are numerous cases in which patients have contrived to harm themselves, without any apparent reason, by introducing foreign substances into their bodies. It can hardly be imagined that any person of sound mind would endeavour to make a pin-cushion of herself, but there are on record several cases of girls and grown women, who have not only introduced pins and needles by pushing them beneath the skin, but have also swallowed those necessaries as part of their regular diet. It must be owned that, in the majority of instances, this has occurred to patients afflicted with hysteria, and lunatic asylums naturally afford a large proportion of the cases recorded. But persons apparently sane, and with nothing whatever the matter with them, have occasionally indulged in the curious pastime of swallowing and charging their flesh with pins and needles.

When, by accident, a solitary needle has been broken short off in any part of the body, the surgeon has great difficulty in displacing it, for it generally leaves no trace of its path, and any effort to remove it with the forceps will infallibly drive it farther into the flesh, unless fortunately it is at once seized. For this reason, as in cases where fragments of metal have flown into the eye, a powerful magnet is often employed to remove it. In other cases, where its exact locality cannot be ascertained, a compass-needle will show by its sympathetic deflection the near presence of a metallic body. Another method employed of recent years is represented by an ivory probe furnished with two wires in connection with an electric bell, which rings directly the wires are bridged across by touching the particle of metal buried in the wound.

If such difficulties arise in the case of a single fragment of metal, how much more care is required in dealing with patients whose bodies are the receptacles of not one, but hundreds of needles! A French surgeon records the case of a woman who swallowed such a quantity that at her death fifteen hundred were extracted from different parts of her body. In another case 320 were extracted from a girl, but whether she swallowed them or introduced them through the skin was never ascertained, although for a time she was carefully watched. A curious part of these stories is, that the foreign bodies seem to have had no deleterious effect upon the general health. In the case just referred to the needles behaved in the most peculiar manner, coming out head first in various parts of the body, and generally in series. Thus, in one day sixty made their appearance, preceded by some pain and fever. Another well-authenticated case is that of a girl who swallowed a large number of both pins and needles, which appear to have wandered about her frame for two years before giving any indication of their presence. At the expiration of that time, and covering a period of nine months, 200 needles and pins emerged from her skin at the hands, arms, thorax and other parts. Another case, brought before a scientific society in Dublin, recorded the removal of 300 needles from a woman's body, who owed her death to their presence. But it is remarkable how little, as a rule, these eccentricities of behaviour have interfered with the general functions of life; and it is still more singular that in the majority of cases examined *post mortem*, death has not been due to the cause which would seem most probable.

MAGNETISM.

An ordinary horse-shoe magnet—such as we can buy at any toy-shop—gives evidence that it possesses properties of a very wonderful and mysterious nature. The great Faraday, who perhaps experimented with the magnet, and knew more about it, than any other human being, was once watching a companion who was idly handling a magnet, so as to attract a balanced needle. The great man remarked "How mysterious is that power you have there ; the more I brood over it the less I seem to know." That mysterious power which seemed so inexplicable to the master-mind of Faraday has not even to this day found a seer who can tell us what it is.

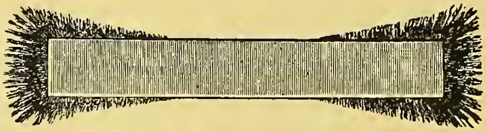


Fig. 1.—MAGNET AND FILINGS.

The ancients were acquainted with a certain black stone, found, among other places, at Magnesia, in Asia Minor. This stone exhibited the property of attracting small pieces of iron, and after a time it became known as a magnet, from the place named above, where it was found. About the twelfth century it was first noticed that this stone, if suspended by a thread so that it was free to move, invariably placed itself north and south. This directive property of the magnet soon caused it to be used for the guidance of mariners at sea, and hence we have the mariner's compass. The Chinese claim to have known this property of the magnet 3,000 years ago, and to have taken advantage of it in journeying across wide expanses of country.

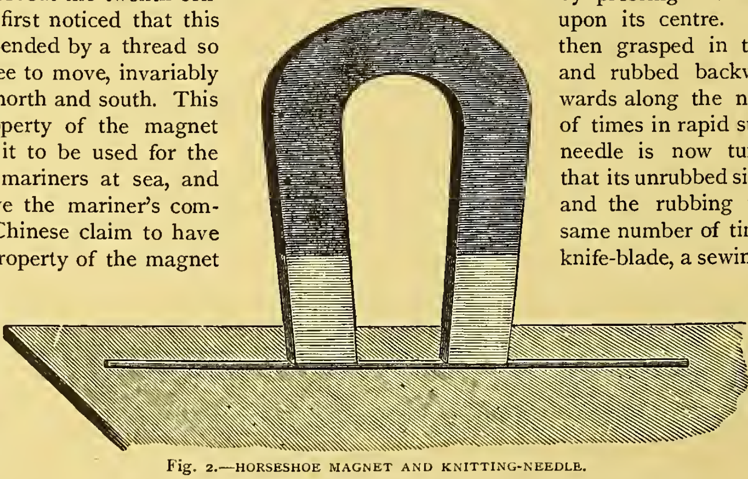


Fig. 2.—HORSESHOE MAGNET AND KNITTING-NEEDLE.

The natural magnet, or lodestone, is an iron ore, now known as magnetic ; it has the chemical composition Fe 3 O 4, and is found in various parts of the world. It was soon discovered that a piece of steel, if rubbed on the natural magnet, or lodestone, acquired its magnetic properties, and would afterwards behave in all respects as a magnet. Such pieces of steel are known as *permanent* magnets, in contra-distinction to *electro-magnets*, the nature of which will be presently explained.

Permanent magnets are commonly sold of a horse-shoe shape, but for experimental purposes a straight bar-magnet is to be preferred. The magnetic power is found to reside principally at its two ends, and this fact can be rendered evident to the sight by scattering over the magnet a quantity of iron filings. These will be attracted towards the extremity of the bar in such a way, that they will hang there in thick clusters (Fig. 1), just as if the particles of iron were little beads which had been threaded together, and hung to the magnet in short lengths. It will now be understood why magnets are commonly made of the horse-shoe form. The strange power being resident at the ends of the bar, these two ends are bent towards one another, so that they can act together. A horse-shoe magnet, therefore, is merely a bar-magnet bent for convenience' sake.

As a natural lodestone was able to confer its properties upon a piece of steel rubbed against it, so is the latter able to affect another piece of steel. If we take a common steel knitting-needle, we shall find it very easy to convert it into a magnet, by rubbing it with a horseshoe-magnet in a particular manner. It should be laid on a table, and held there firmly, by pressing the left hand thumb upon its centre. The magnet is then grasped in the right hand, and rubbed backwards and forwards along the needle a number of times in rapid succession. The needle is now turned round, so that its unrubbed side is uppermost, and the rubbing is repeated the same number of times (Fig. 2). A knife-blade, a sewing-needle, or any other piece of steel, can be magnetised in this way, but for purposes of experiment the knitting-needle is most convenient. Our knitting-needle is now a magnet, as we can prove by dipping it into iron filings, which will cluster round its ends, as just now they clustered round the bar-magnet in Fig. 1.

There is another way of showing that the magnetic force is chiefly resident at the ends of a magnet, and there is perhaps no prettier experiment in the whole region of physics. The magnet—whether horse-shoe or straight being immaterial—is placed on a table, or other flat surface. Above it is placed a white card. Iron filings are now sifted over the card from a muslin bag, which retains all particles over a certain size. The card, being well dusted over with fragments of iron, is now gently tapped at one corner with the finger-nail. Immediately the iron filings begin to arrange themselves in a certain order, forming beautiful feathery curves, which seem to spring from two spots, and blend with one another in the most curious manner. Upon gently lifting the card, it will be seen that these two spots from which the curved lines spring are just above the ends of the magnet beneath. These curious lines are known as the curves of magnetic force, and show optically what a curious atmosphere of power—if we may use such an expression—surrounds the ends of a magnet.

It is customary to call these ends the poles of the magnet. If we suspend the bar of magnetised steel by a thread, we shall find that it will naturally take up a position north and south. We may place it east and west, but directly it is released it will vibrate backwards and forwards, until it assumes once more its normal position. While hanging thus suspended by its centre, we must notice its behaviour when another magnet is approached towards it. It will be either attracted or repelled, according to which end, or pole, of the magnet we present to it. Hence it will be seen that the two poles show distinctive qualities, and one is known as the north pole, and the other as the south pole. It is usual to mark that end of a magnet which points to the north, and that end is commonly known as the north pole of the magnet. We shall presently see that this has led to some confusion of terms. Summing up the results of our experiments on the attitude of one magnet towards another, we find that dissimilar poles, north and south, attract one another, and similar poles—two norths or two souths—as the case may be, repel one another; so that with a magnet properly marked at one end we can easily find the north or south pole of any other magnet, whether marked or not.

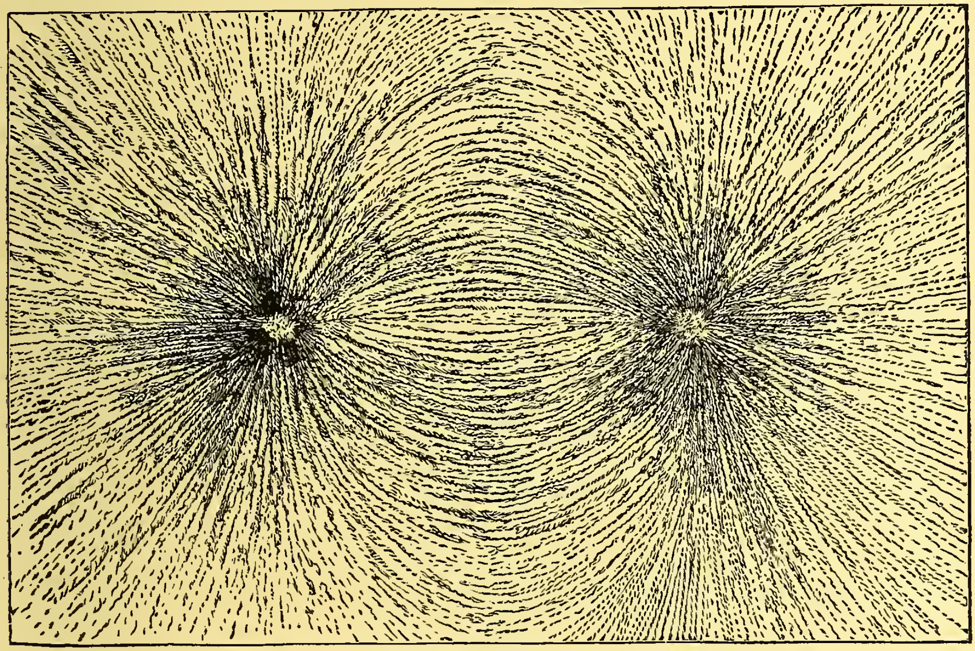


Fig. 3.—MAGNETIC CURVES IN IRON FILINGS.

Dr. Gilbert, who, in 1600, was the first to discover the difference between the poles of a magnet, made a still greater discovery in showing that the earth itself is a magnet, with poles coinciding nearly with the geographical north and south. We shall now see how, by examining the ends of a magnet in the same way, we are apt to be led into ambiguity. If unlike poles attract one another, the north pole of a magnet should of course be at that end which points south, and *vice versâ.* For this reason, many writers use the terms north-seeking and south-seeking, but it has become so much the fashion for manufacturers to mark the north-seeking end with N, that it is commonly called the north pole of the magnet. To obviate the difficulty, Faraday spoke of the *marked* end, and another well-known scientist has distinguished the poles by the colours blue and red. In experiments to show attraction and repulsion, magnets of any size can be used. A mariner's compass can also well take the place of the suspended bar-magnet: indeed, it is really precisely the same thing, only that the needle is balanced upon a point instead of being hung by a thread.

By *magnetic induction* is meant the power which a magnet possesses of inducing magnetism in a piece of iron held near it, and not necessarily touching it. Thus we find that if we lay a bar-magnet on a table, and place a short piece of iron near one of its ends, but not touching it, that filings will attach themselves to the previously unmagnetised piece of metal. We can also prove that this iron has for the time being two poles, and that the pole next the magnet is dissimilar to that end of the magnet. We can thus understand to some extent how the magnet comes to attract a piece of iron. It first induces magnetism in it, and then attracts it, the north pole of the one acting attractively on the south pole of the other.

The effects of magnetic induction can be more curiously shown by attaching to a magnet a piece of iron *a b* (Fig. 4.) This depending piece immediately becomes a magnet by induction, and will support a smaller piece. A third and fourth can

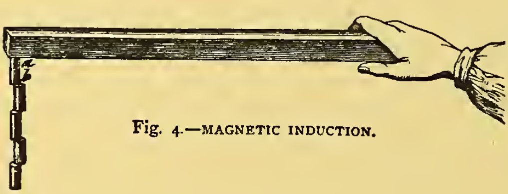


Fig. 4.—MAGNETIC INDUCTION.

be added, until we have quite a little chain hanging to the original magnet. If the magnet be detached from the first piece of iron, the rest will fall, showing that the magnetism conferred upon iron is only temporary. If steel be used, the various pieces will retain their magnetism.

It will be seen from the foregoing that the two opposite poles, or different kinds of magnetism, may be compared to the negative and positive states of electricity, and in their inductive properties are very similar in behaviour. But there is one important point of difference which is worthy of notice, and that is, that in electricity, when one body comes in contact with another so as to influence it inductively, it gives up some of its charge. The magnet, on the other hand, may be used to magnetise any number of others, and will retain its strength. It should, however, be noted here that the so-called permanent magnets do to some extent lose their power, certain machines in which such magnets have been used for many years having been found to have relinquished a large amount of their original power.

One more experiment with iron filings will give us an idea of the intimate connection between magnetism and electricity. A copper wire stretched between the terminals of an electric battery will be found to be strongly magnetic, and will attract iron filings. Directly the circuit is broken, the filings will fall off, showing that the magnetism continues only so long as the current traverses the wire. If we employ a powerful battery, and lead from its terminals a copper wire covered with cotton or other material, so as to insulate it, we shall find that on coiling it round any bar of iron, the bar will become strongly magnetic. If the bar be of soft iron, it only remains magnetic while the current passes; if it be of steel, the magnetism is retained by it. The power given by this method of making a magnet is much greater than that before described. A soft iron bar, coiled with wire, and usually of the horse-shoe form (Fig. 5), is known as an electro-magnet. Large electro-magnets, when thus excited by a copious voltaic current, are of immense power, far exceeding that of any permanent steel magnets which can possibly be constructed. For instance, it is perfectly easy to construct electro-magnets which will sustain many hundredweights from their keepers or armatures, and quite a small one will sustain many pounds; whilst a permanent steel magnet, of even the last power, must be a compound one of great size, and very costly.

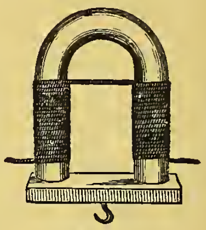


Fig. 5. ELECTRO-MAGNET.

This power of generating magnetism in soft iron by means of the passage of an electric current in a wire surrounding it, has been taken advantage of in the construction of many contrivances: indeed, it would be pretty safe to assert that in any machine actuated by electricity the electro-magnet

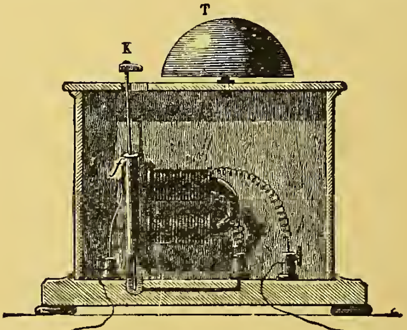


Fig. 6.—ELECTRIC BELL.

is the principal feature. One reason why this form of magnet is so useful is that its action is not only energetic, but it is very quick. The moment the current is applied the magnetism is created, and directly the current is broken it departs. Indeed, by employing a vibrating piece of metal as a contact-breaker, the iron can be magnetised and demagnetised several hundred times in a second. This is taken advantage of in the common form of electric bell which is so much used in hotels and private houses. An electro-magnet is made to attract a piece of iron, called the armature, *f;* to this armature is fastened the little hammer (K) which beats on the gong, or bell (T), every time contact is made with the battery. By a simple arrangement, the armature is made to break contact in the act of being attracted to the magnet, so that we have a series of contacts and breaks, which give the hammer a trembling movement.

The magnetism of the earth is sometimes found to have magnetised bars of steel which have remained in an upright position for a long time. It is also possible to magnetise a bar, such as a poker, by holding it in the magnetic meridian, and striking it with a mallet so as to make it vibrate. Bars of steel are also endowed with magnetism if they are brought to a red heat, and allowed to cool while lying north and south, but no such action occurs if their position be east and west during the cooling process. Magnets of a very powerful character have recently been made of cast-iron, by placing the moulds in which they were cast between the poles of an electro-magnet—or, in other words, in a magnetic field.

The magnetised needle in the ordinary mariner's compass is mounted horizontally, and its movement is therefore horizontal. But if a magnetised needle be mounted so that it will move vertically, it will be found to dip towards the earth ; in other words, its marked end will point to the north pole of the earth directly, *i.e.*, through the earth itself. The direction of this dip will be different for different latitudes. Thus, at the equator—or, to speak more correctly, the magnetic equator—the needle will be horizontal, while at either pole it would be quite vertical. The dip and the direction of the needle vary at different hours of the day, and such changes are noted at our observatories by special apparatus.

THE ORIGIN OF FIRE.

FEW amongst us perhaps ever give a thought to the immense importance of the possession of fire to the whole of the human race. To it we are indebted for heat, light, and even for the preservation of life itself. To its influence is to be attributed in no small degree the sociability so characteristic of humanity; nor, probably, would even our family ties remain as close and intimate as they are were we deprived of this useful and important servitor. Without fire, too, we should be without the means of pursuing those innumerable arts and industries to which alone is due the material progress which has been made by all the families of mankind. To it the world has been indebted for many religious rites, and in ancient times fire was an important agent in the burial ceremonials of the Chaldees, the Hebrews, the Greeks, and the Romans; while amongst the Persians, Hindoos, Peruvians, Mexicans, and others, it still holds a place in the religious observances of the people. In some countries, indeed, the worship of fire has been the chief religious ceremonial of the inhabitants, and the priests of Baal, the Ghebers, or fire-worshippers of Asia, the priests of Brahma in India, the Vestal Virgins in Rome, and the priestesses of the Sun in Peru, have all ministered at the shrine of Fire, regarding it not alone as a powerful and useful ally—as, indeed, it deserved to be regarded—but as a god, to be worshipped and respected.

Of the discovery of fire there is absolutely no record; and though it has sometimes been affirmed that certain tribes of savages were ignorant of its use, yet all the evidence goes to prove that no race or family of men exists, or ever did exist within the historic period, to whom the use of fire was entirely unknown. Certain of the Australian tribes have, indeed, been met with who either were ignorant of all means of procuring fire, or who regarded it as too tedious an operation to be needlessly undertaken, and these were accustomed, upon the accidental extinction of their own fires, to seek a fresh supply from their nearest friendly neighbours.

That there are many means by which fire might be obtained by people quite unacquainted with its artificial production, cannot be doubted. From lava-flows and other volcanic disturbances, more common apparently in past ages than at the present time, fire could frequently have been obtained in many parts of the world, while the accidental rubbing together of two dry branches during a steady wind or the vivid lightning of the tropics might also be a not uncommon source of fire, and now and again perhaps the spontaneous combustion of vegetable matter led to a similar result. Still the fact remains that from the most remote ages of which we have any knowledge man has been in possession of this most useful agent, and has moreover, in all probability, possessed the knowledge requisite for its artificial production.

The Indian and Greek mythologies represent man as having ascended to heaven, and there seized upon a fragment of celestial fire, which was ultimately disseminated throughout the world. The fable of Prometheus relates how that individual, by the aid of Minerva, climbed to the heavens, and stealing fire from the chariot of the sun, brought it down upon the earth at the end of a ferula. This fable is almost identical with the mythological account contained in the Vedas of India, in which the god Agni is represented as lying concealed in a hiding-place, until forced by Matarichvan to leave his retreat, and to communicate to Manou, the first man, or to Bhrigu (the Brilliant), the ancestor of the priestly family of the same name, the secret of obtaining the much-coveted element. Now strangely enough, philology shows that the name of Prometheus is of Vedic origin, and in fact records the means employed by the ancient Brahmins to obtain fire. For this purpose they employed a stick of wood, called *matha*, or *pramatha*, the prefix *pra* adding an idea of force to the root *matha*, of the verb *mathami*, or *manthnami*, meaning to produce by means of friction. From *Pramantha*, or Pramanthyus, the transition to the Indian Pramathyus and to the Greek Prometheus is simple and natural; while, to add to the importance of the heathen deity, it is related of him that he fashioned the two earliest human beings in clay, and kindled in them the spark of life by means of the fire which he had filched from heaven.

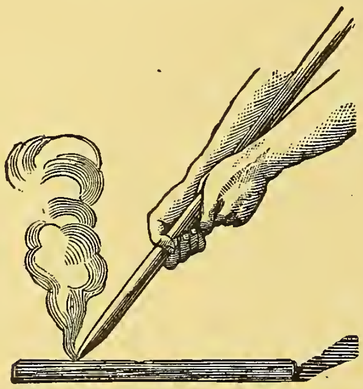


Fig. 1.—STICK AND GROOVE.

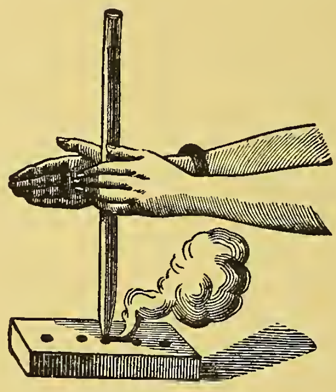


Fig. 2.—FIRE-DRILL.

To the *pramatha*, or fire-stick, at its upper end, was attached a cord of hemp mixed with cow's hair, by means of which the priests of Brahma were enabled to impart to it a rotatory movement, alternately from right to left and from left to right. The lower end of this rod was inserted into a small cavity situated at the point of intersection of two small pieces of wood, placed transversely one upon the other in the form of a cross, the extremities of which were usually bent at a right angle, and were firmly fixed by four bronze rivets, so that they remained perfectly firm and rigid. This implement, which was called the Swastika, is figured in various forms upon the spinning-whorls or baked earthen discs found in such abundance by Dr. Schliemann beneath the ruins of Ilion, and has been regarded as additional proof, if proof were needed, of the Aryan origin of the Trojans; while certain rites which gradually crept into the Church of Rome, analogous to some of the ceremonies of the fire-worship of Agni, are also regarded as favouring the community of origin of the two races. The parent of the sacred fire was called Twastri, or the Divine Carpenter, and by him were made the *Swastika* and the Pramatha, by the rubbing together of which was produced the holy infant Agni—in Latin, *Ignis*.

Fig. 3.—FIRE-DRILL, FROM MEXICAN PAINTING.

These early mythological accounts of the origin of fire are of great interest, though, of course, as facts they are totally unreliable. Nevertheless, when we turn to practices which it is still possible to observe, we are able to perceive how such myths may have come into existence amongst a primitive, superstitious, and poetical people.

Probably the earliest of all methods for the artificial production of fire was the rubbing together of two pieces of dry wood, but this must have been an exceedingly slow and tedious process, and doubtless all the ingenuity of the primitive races was employed in the discovery of an easier and quicker method. Accordingly we find in use amongst the inhabitants of New Zealand, Tahiti, Tonga, Samoa, the Sandwich Islands, and other places, what has been termed by Mr. E. B. Tylor the Stick-and-Groove (Fig. 1). This consists of a small piece of dry wood, along the grain of which a small channel has been formed, into which is inserted the end of a sharp s ick, also of dry and hard wood. By sliding this stick backwards and forwards with great rapidity and with considerable force, small sparks of fire are at length produced,

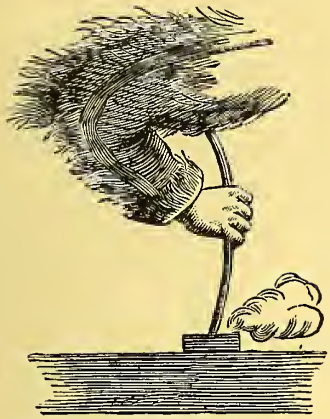


Fig. 4.—FIRE-DRILL.

which are carefully made captive, and at length fanned into a flame.

A commoner and more widely-spread implement for the production of fire is, however, the Fire-drill (Fig. 2), of which there are a multitude of varying forms. It is met with in one shape or another in Australia, Sumatra, and the Caroline Islands, in

Fig. 5.—THONG DRILL.

Kamtschatka, and in other parts of North and South America, in China, and in Africa ; and it has also been observed in use amongst the hill tribes of Ceylon and the barbarous Gauchos of South America.

The simplest form of this instrument is that commonly used by the savage natives of Australia. It consists of an arrow-like stick, cut at one end to a blunt point. This is inserted in a small hollow in an under-piece of wood, and is then twirled round between the hands with such rapidity and force that at length the charred dust worked out in the process of boring becomes ignited. It is said that by this means fire can be obtained in a few minutes ; but great skill and knack, as well as a

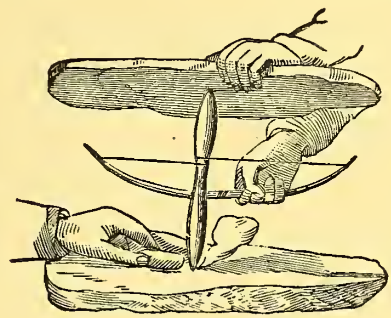


Fig. 6.—BOW DRILL.

knowledge of the best wood to use for the purpose, are needed, and the operation would probably be not only tedious, but absolutely impossible to those quite uninitiated in the art. To prove how ancient is this method of procuring fire, we have an antique drawing of an early Mexican in the act of churning fire in this manner (Fig. 3) ; while in India, the high priests of Brahma, if by chance the

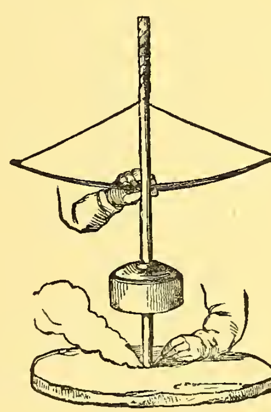


Fig. 7.—IROQUOIS DRILL.

sacred fire burning upon their altars should be extinguished, still resort to this early practice of their ancestors to re-kindle the divine flame, though well-acquainted with other methods of obtaining fire, and doubtless in many cases supplied with lucifer-matches. Another form of fire-drill, in use amongst the wild Gauchos of the American pampas, is shown in Fig. 4, and consists in a stick of wood slightly bowed, which, while resting upon an under piece, is turned rapidly with one hand, the other being employed in putting pressure upon its upper end.

The Esquimaux and the inhabitants of the Aleutian Islands have advanced somewhat farther than this in their fire-making apparatus, and use what has been termed the Thong drill. This, like the former, consists in a blunt-pointed stick placed upon a small block of wood. Its upper end is, however, inserted into another fragment of wood, which is held firmly between the teeth, while a cord twisted two or three times round the stick is held by its two ends, and is pulled rapidly backwards and forwards by the hands, imparting to the implement a quick rotatory movement with comparatively little labour (Fig. 5).

A still farther advance is seen in the Bow drill, in use among the Sioux and some of the Indian tribes of British North America (Fig. 6); while the famous Iroquois have from the earliest times made use of what has been termed the Pump drill, by which means one hand is left at liberty to gather together the sparks as they are thrown off from the "fire-stick," while the other easily works the bow up and down, by which the rotatory motion is maintained (Fig. 7).

Such are the primitive appliances by which fire has been obtained, nor have many years elapsed since similar customs died out in some parts of Europe, and even in Britain. It was long usual, upon the appearance of a murrain amongst cattle, to kindle a "need-fire," through which the herds were driven to preserve them from the scourge, and this fire was obtained by means of friction. As lately as 1826 "wild-fire" was thus obtained at Perth for this purpose; and in Sweden, even in the present day, these "need-fires" may perhaps still be seen, kindled upon the occurrence of cholera or other infectious disease. And it is curious to observe, as pointed out by Mr. Tylor, that during the last century a law was passed prohibiting the superstitious friction-fire in the district of Jönköping, which has since become famous for the cheap Swedish matches known as *tandstikor*, or tinder-sticks.

In obtaining fire by means of friction, all that was necessary was, of course, the production of a single spark, which was made captive in a bunch of dry grass, or in dry leaves or bark prepared, and sometimes even carbonised, for the purpose. And presently it came to be known that this spark could be more easily obtained by striking together two fragments of hard stone, or a fragment of stone and another of metal, than by the more tedious process of continuous friction. At first, probably, the nodules of iron pyrites often to be picked up along the sea-coast were employed together with fragments of flint for this purpose, and the name pyrites is clearly derived from the Greek *purites*, which was not only the name of the mineral, but also meant "fiery," thus bearing witness to the probable origin of the flint and steel. The use of the flint and steel continued in Europe from the earliest historic period almost to the present time; and it was not until about the year 1834 that the lucifer-match, with which we are all now so familiar, came into ordinary use. If all these modern appliances could now be destroyed, and the art of making them were lost, the state of affairs can perhaps be better imagined than described.

CURIOSITIES OF WEIGHT.

WEIGHT is a variable quality. A stone of potatoes weighed at the base of a mountain in a pair of ordinary scales is not a stone when taken to the top of the mountain and weighed again in a spring balance. Still, the potatoes have lost none of their substance.

The same stone of potatoes, if it could be suddenly transported four thousand miles away from the earth's surface, would only weigh a quarter of a stone in the spring balance!

Again, our stone of potatoes would weigh more than a stone if we could weigh it on the surface of a planet like Jupiter. We should now find that we had got slightly less than two and a half stones.

These apparently anomalous facts are readily explained. Weight is caused by gravity, or that universal attraction which subsists between all kinds of matter. Our stone of potatoes is drawn towards the earth by this attraction when on the scale of the balance, and its tendency to go down is not stopped until a number of iron weights have been put in the other scale, which are drawn towards the earth to the same extent; therefore the iron weights counterpoise the potatoes. The farther one gets away from the earth or any other planet, the weaker its attraction becomes; hence the pull of gravity on the stone of potatoes at the top of a mountain and four thousand miles away is much weaker than it was at the base of the mountain when tested by a spring balance. On the other hand, the attraction of gravity increases the more matter there is in the planet which is exerting its influence. For this reason a particular weight which stretched out the spring of our balance to a certain extent on the earth would stretch it out much more on the surface of Jupiter, the latter planet having a much greater mass than the earth.

On the earth's surface all substances have not the same weight when compared *bulk for bulk*. Platinum, for example, is twenty-two times heavier than water, while at the opposite extreme the metal lithium is only a little over half the weight of water. Lead is usually looked upon as an extremely heavy metal, but it is only about half the weight of platinum. Among compounds, the sulphate of barium has been called heavy spar on account of its weight, although it is only about four and a half times heavier than water. It was its heaviness which led Cascariolo, the Bologna cobbler, to take it home in the hope of extracting gold from it; and by his experiments he obtained from it a substance which appeared to shine in the dark, the sulphide of barium.

The question is sometimes asked, "Which is the heavier: a pound of feathers or a pound of lead?" In commerce they pass as being equal; but in reality they are not of equal weight unless the weighing be performed *in vacuo: i.e.*, in a space void of air, like the exhausted receiver of an air-pump. As they are usually weighed, both the lead and feathers are buoyed up by the amount of air they displace, and since the feathers displace more air than the lead, more feathers have to be added to make the pound than would be required *in vacuo.* In other words, a pound of feathers, as usually weighed, would weigh more than a pound of lead if the re-weighing were performed in a vacuum.

The greatest of all sublunar weights is the weight of the earth itself, and probably the least, at all events as far as we can ascertain, is the weight of an atom of hydrogen. We speak of the weight of the earth in trillions of tons, and of the weight of the atmosphere in billions of tons, and of some other large masses—like icebergs, for example—in millions of tons. A tiny speck of dust may weigh much less than the thousandth part of a grain. It would be hard to tell, however, what is the weight of one of those quickly-moving organisms, like *euglena*, which the microscope has revealed to us; yet infinitesimal as it is, they have a weight, precise and of such relation to their bulk that they live and move, and fulfil their appointed tasks without any apparent difficulty.

THE BIGGEST BOOK IN THE WORLD.

THE Chinese Department of the British Museum Library contains a single work which occupies no fewer than 5,020 volumes. This wonderful production of the Chinese press was purchased a few years ago for £1,500, and is one of only a very small number of copies now in existence. It is an Encyclopædia of the literature of China, covering a period of twenty-eight centuries—from 1100 B.C. to 1700 A.D. It owes its origin to the literary proclivities of the Emperor Kang-he, who reigned from 1662 to 1722. In the course of his studies of the ancient literature of his country, Kang-he discovered that extensive corruptions had been allowed to creep into modern editions, and he conceived the idea of having the text of the originals reproduced, and preserved in an authorised form. This was a mighty conception, truly, and in its execution it remains unique down to the present time. For the purpose of carrying out the work, Kang-he appointed a commission of learned men to select and collate the writings to be reproduced, and employed the Jesuit missionaries to cast copper types with which to execute the printing. The commission was occupied for forty years in its great task. Before the work was completed Kang-he died, but he had provided that his successor should see the book completed, and he faithfully carried out his trust. The book is arranged in six divisions, each dealing with a particular branch of knowledge. The divisions are thus designated:—1, writings relating to the heavens; 2, writings relating to the earth; 3, writings relating to mankind; 4, writings relating to inanimate nature; 5, writings relating to philosophy; and 6, writings relating to political economy.

THE CANDLE-FISH OF BRITISH COLUMBIA.

THERE is found, in some of the rivers of British North America, a species of smelt so rich in oil that it may when dried be used as a candle or torch. This curious and useful fish is of slender make, and measures about a foot in length. It is silvery white, and is regarded by the natives to be the most delicious of edible fishes. At certain seasons the fish swarms up the rivers from the sea, and is then caught by the natives in wickerwork traps. During the fishing season, which lasts from two to three weeks, it is a staple article of food. Large quantities are dried for future consumption, and from others the oil is extracted and preserved. The dried fish furnish excellent food; but their most remarkable use is that of an illuminating agent. When a candle is required a dried fish is stuck, tail upwards, in a lump of clay or in a cleft stick; a light is applied to the tail, which instantly flames up, and the fish burns steadily downward, giving a light superior to that of the best quality of "dips." The fish is, however, most successfully used as a torch, because in moving it through the air the rather dense smoke which it emits is got rid of. So highly is the fish prized for its illuminating qualities, that the natives of the region in which it is found find a profitable trade in bartering it with the people of less-favoured districts. The oil of the fish is of a yellow whitish colour, and at a medium temperature assumes the consistency of thin lard. This oil is used for many purposes, but is most highly prized for its medicinal qualities. It is said to be as efficacious as cod-liver oil in pulmonary diseases, and has the advantage of being much more palatable. The scientific name of this fish is the *Thaleichthys pacificus.*

THE CANNON-BALL TREE.

THE CANNON-BALL TREE.

THE Cannon-ball tree (*Couropita guianensis*) is a remarkable plant, inhabiting the extensive alluvial plains skirting the rivers of British Guiana. It belongs to the myrtle family, and is closely related to the Brazil-nut tree. An idea of its general appearance will be gathered from our illustration, taken from *The Gardener's Chronicle*, and which was engraved from a photograph of a young tree growing in the Promenade Gardens, Georgetown. Its large and globular fruit plentifully produced has given the plant its very appropriate name. The natural height of the tree reaches eighty to a hundred feet, or even taller, with straight, unbranched stem having a thickness of eighteen inches or thereabouts. It bears a dense "hive-shaped" head of dark green leaves, which suddenly fall away some time during the month of March, and are rapidly (in a few days) replaced by a fully-matured foliage of the brightest and freshest green. The flowers are large, of a pinkish colour, and highly scented, and are freely produced along the elongated flowering branch. The fruit is a hard globular capsule, six inches or more in diameter, containing numbers of flat circular, pulp-imbedded seeds, rather larger than a sixpenny-piece. The fruit, says Kingsley, is a "rough brown globe, as big as a thirty-two-pound shot, which you must get down with a certain caution, lest that befall you which befell a certain gallant officer on the mainland of America. Fired with a post-prandial ambition to obtain a cannon-ball, he took to himself a long bamboo, and poked at the tree. He succeeded, but not altogether as he had hoped. For the cannon-ball, in coming down, avenged itself by dropping exactly on the bridge of his nose, felling him to the ground, and giving him such a pair of black eyes that he was not seen on parade for a fortnight."

A SMUGGLING MUSEUM.

EVER since it became customary for the government of a state to raise revenue by imposing duties on certain articles of consumption there have been found persons who will do their best to evade payment. In the case of this country such attempts at smuggling are constantly brought before us by the published convictions in the various police courts, and there are few that are unaware that the punishment awarded consists of a heavy fine, besides the payment of treble duty, and confiscation of the goods seized. In default of payment, the delinquent is condemned to a term of imprisonment.

Although these convictions are frequent enough, they bear a very small proportion to the number of cases which occurred only a few years back. There is more than one reason for this reduction. In the first place, the number of commodities upon which duty is levied is considerably reduced. When jewellery, watches, lace, and other luxuries easy of concealment on the person, were heavily taxed, there was a great temptation offered to both the professional and amateur smuggler. Then, again, such articles as now carry customs dues are much less heavily taxed than they were in times gone by, therefore there is not the same profit to be had from their concealment, while the risk of discovery remains the same as ever. Tobacco and ardent spirits have always borne a heavy duty, but it is now about half what it was a few years ago. In spite of this, these two luxuries, perhaps owing to the universal demand for them, are still favourite goods with smugglers, and the first-named, from its portable character, is by far the most commonly found in such hands. We see, then, that there are causes for the decline of smuggling as a fine art, if the term may be used in such a connection. We think that it may; for the ingenuity exercised in evading the law certainly raised the perpetrators far above ordinary criminals. That this was so may be judged from an inspection of a collection of articles seized from smugglers which are now preserved as curiosities at the Custom House, London.

These curiosities of law-breaking assume many different forms, and, with few exceptions, have been contributed by passengers and members of the crew of steam-vessels trading between London and the various continental ports. Let us look at these examples one by one, as we learn from their custodian their objects and uses. Here is a great coat, and a very ordinary-looking coat too. Was there ever a duty upon coats? we mentally ask ourselves. Our conductor turns the coat inside out, and shows that it is literally honey-combed with little pockets, each constructed to hold a watch. The individual who owned this valuable hide was discovered with 150 watches concealed in it. Another way of hiding watches is next pointed out. It is a venerable-looking volume with leather binding. We open it and find that the leaves are cut through inside in circular pits, each one of which would hold several timekeepers. Another garment, technically known as a petticoat, is very ingeniously arranged to hold brandy. For this purpose a number of long fish-bladders, like huge sausage-skins, depend from the waist-band, their total capacity being several gallons. Another petticoat is ingeniously sewn with cigars, which make a kilted edge of great regularity, while another is furnished with flat pockets to hold twenty-seven pounds of cake tobacco. The latter material is also made up into pieces the shape of the sole, so as to be carried inside the boots.

But the various modes of concealing goods show far more inventive talent where they are carried separate from the person, and probably every portion of a ship and its furniture has at some time or other served as a hiding-place. Cigars strung together end to end on a long line have been found dropped between the outer and inner skin of the vessel ; blocks of wood, ships' fenders, and other articles, including even a loaf of bread, are here shown hollowed out and stuffed with contraband tobacco. Even the rigging has helped in the work, for here are ships' blocks, with wheels inside, instead of being constructed of iron, made of compressed tobacco. Our attention is next directed to a pigeon cage, which at one time belonged to a certain enterprising stewardess, who added to her income by carrying pigeons from Rotterdam. Pigeons not being subject to any tax, one was clearly at liberty to do so ; but unfortunately it was found that the cage had a false bottom, under which was concealed a quantity of Cavendish tobacco. We may mention that the same birds have more recently been detected as aiders if not abettors to the smuggler. Two dozen carrier pigeons were let off regularly from Belgium to find their way across the French frontier : each bird being burdened with about fifteen grammes of tobacco in the form of a coil. One of the birds fell exhausted in the Seine, and this led to a discovery of the system, which was speedily stopped. Another still more cunning and bold way of cheating the revenue is represented by a cake of material which well imitates the oil-cake upon which cattle are fattened. A large quantity of this stuff was imported, but was found on examination to consist of compressed snuff. The duty on oil-cake was about a penny per pound, while that on snuff was three shillings or more ; so that the substitution of one for the other left a considerable margin for profit on the transaction. Sometimes the smugglers have been too cautious to trust their goods inside the vessel, for bladders of spirit and tobacco, and in other cases lobster-pots full of various articles, have been found floating, but attached to a cord below the water-line.

For many years it was customary to destroy the goods smuggled, and they were taken to a furnace in the London docks which was crowned by a huge chimney-shaft. This receptacle was known as the Queen's tobacco-pipe, and sometimes it emitted its fragrant smoke for many days together. Of late years this wasteful procedure has ceased, and the forfeited tobacco has been consigned to the commissariat officers for distribution among our soldiers when on active service. As we have already hinted, smuggling is on the decline. Such cases as now come before our magistrates are of the most commonplace character, and bear very little of that romance about them which used to hang about the doings of the bold buccaneer. Not long ago, a parcel of tobacco weighing 34 lbs. was dropped on the beach at New Brighton, and remained unclaimed. This proves in a measure that the Customs officers are well on the alert. There is little likelihood that the ingenious methods of smuggling goods which we have enumerated will ever be repeated.

GIANT CHANGES IN JUPITER.

MANIFOLD as are the wonders displayed amongst the celestial bodies, there are few perhaps of more striking interest than that exhibited by the largest planet of our solar system—Jupiter. Apart from his enormous bulk, which enables his leading features to be discerned with telescopes of very moderate capacity, he shows unmistakeable evidence that his surface is in a state of great commotion. Highly-coloured markings of large extent and definite outline appear on his disc, and give rise to a remarkable series of phenomena very difficult of explanation, but which are certainly the outcome of marvellous forces such as have no analogy upon the surface of our own earth. This is rendered patent by very recent results of telescopic scrutiny directed to this planet, and is moreover corroborated by former observations.

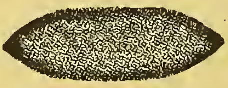


Fig. 1.—THE RED SPOT.

In 1878 there appeared a large red spot on Jupiter's southern hemisphere, and this curious formation has certainly caused the planet to receive more attention than at any other period since the invention of the telescope. The spot we allude to is of extraordinary size, the approximate dimensions being 29,000 miles in length and 8,300 in breadth. It is elliptical in form, with tapering ends, and the major axis lies perfectly parallel with the dusky belts of the planet. The early history of this singular object is merged in doubt, for when in July, 1878, it first conspicuously attracted notice, it was already well developed, and we cannot trace its earlier stages of formation from prior observations. We may, however, safely assume that in 1877 the spot could not have been visible under the same bold aspect as that which immediately led to its detection in the summer of 1878.

During the four years which have now elapsed this object has preserved its integrity of figure and persistency of appearance. It is now fainter than formerly, and black specks are visible at the ends (Fig. 1). We may infer that these changes indicate the approaching disappearance of the spot. It has served some useful purposes, the most significant of which is that it has enabled a rotation-period for the planet to be determined with a degree of certainty far surpassing all previous efforts. This is now found to be 9h. 55m. 35s., which is nine seconds in excess of the value formerly adopted.

The apparition of this great red spot upon the surface of Jupiter naturally leads us to ask what is the cause of such a monstrosity? Is it a gap in the outer envelope of Jupiter, through which we are enabled to discern the ruddy tint of the region below, or is it merely a mass of aqueous vapour suspended over the planet? Must we assume that it is the result of extraordinary cyclonic action, or was the spot more probably formed by the emission of gases from the lower shell of the planet, which have condensed upon being confronted by colder regions without, and are thus formed into a compact and permanent mass? In any case this wonderful spot affords ample evidence of gigantic changes going on in the planet, and is certainly one of the most notable features which has ever come within the power of telescopic revelation. The probability is that it is situated on the extreme outer shell of Jupiter, and that it is an elevation, because the black specks on the interior margin of the spot are very plain when close to the planet's limb. They would disappear entirely in this position were they placed on the sloping sides of a cavity. Moreover, the distinct outline of the spot is invariably preserved, and this sufficiently shows it to be situated above those regions of the planet most affected by atmospheric currents and gaseous ejections from the probably heated surface below.

The slow rotation of this red spot also affords evidence that it is a phenomenon of the outer surface, for its period of 9h. 55m. 35s. is no less than 5½ minutes greater than that of a brilliant white spot which has been visible during the last three years at least, shining amid the dark belts of the planet's equator. The latter shows a much swifter motion, for it crosses the central line of Jupiter, at intervals of 9h. 50m. 6s.; and the writer has witnessed its re-appearances in this position on numerous occasions, for the purpose of determining its rate of motion and learning something of its singular behaviour. It varies rapidly: sometimes it is brilliant, while now and again it is so faint that only intent gazing and the application of the highest telescopic power will succeed in revealing it. These temporary obscurations admit of ready explanation. They are caused by the passage of dark, semi-transparent masses over the spot, for when it appears faint there is always seen a dusky condensation lying immediately near it. These remain for a few days, until receding from the position of the bright spot, the latter is enabled to recover its accustomed brilliancy, and it becomes at once one of the most noticeable and wonderful features visible upon the planet's surface (Fig. 2).

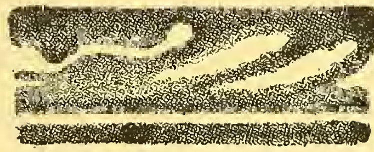


Fig 2.—WHITE SPOT.

These variations, together with the greater velocity and fairly regular motion of the bright spot, lead us at once to the inference that it is situated below the red spot in Jupiter's cloud-envelopes, and affords us the best clue to the true rotation of Jupiter. The red spot is probably a condensed exhalation on the outer limits, and thus it lags behind the very swift motion of the kernel of the planet, from which it is materially dissociated. The difference of motion in the two spots amounts to 13m. 24s. daily, and in 44½ days the red spot loses ground to an extent equal to one circumference of the planet.

The dusky belts of Jupiter, which are familiar to all celestial observers, have opened up some interesting speculations as to their nature. They are obviously not very permanent features upon the planet, as they change their positions in certain cases, and are sometimes obliterated altogether. New belts are occasionally seen to have formed at short intervals, while others after remaining visible for several months have disappeared, but the progress of these changes never seem to have been studied with critical assiduity until very recently, when the apparition of the red spot attracted the closer attention of observers. During the winter of 1880 a new belt formed upon the planet, and the process was watched during its several stages of development. The position of the new belt was some 25° north of the equator of Jupiter, and we will give some description of this unique occurrence. At first, on October 17, two minute black spots were noticed on a very narrow belt in the position referred to (A). These had increased in size by October 23, and several fainter spots came into view; on October 29 they had further developed so as to extend over 32° of longitude (B). On successive nights they continued to enlarge, and many additional spots appeared, and it was remarkable that the group was extending itself in a perfectly longitudinal direction; so that early in November it constituted an irregular chain of spots lying parallel with the dark belts of the planet. On November 8 the spots extended over 66° of longitude (C). This means that during the ten days from October 29 to November 8 this confluent eruption had more than doubled its length, so that it must have increased some 25,000 miles! On November 23 they were seen to have gone on increasing with marvellous rapidity; for now they covered 120° of longitude, and were in fact entwined around one-third of the planet's circumference! On December 30, the group had become partially detached from the narrow belt from which they were first ejected, and had so far continued to accumulate and disperse that they now covered 281°, which is more than equivalent to three-fourths of the planet's sphere! Towards the end of January the girdle was complete; the planet was encircled by a perfect chain of spots, with only slight irregularities here and there, insufficient to break the continuity of their appearance. But the individual spots, while thus increasing and stretching out, had been losing their definite character, and had now grown somewhat faint, so that the very definite and conspicuous black spots seen during October 23 and November 8 were resolved into dusky patches and specks of irregular form. With increasing faintness they had shown a disposition to leave the belt upon which they were first seen, and were now observed to be scattered along a region slightly nearer the equator (D). In February the spots formed a new belt upon the planet (E), and in the summer months of 1881, when Jupiter came again into favourable view, it continued visible. All traces of the black spots had disappeared, but their rapid dispersion had formed the material of a new belt, lying some distance north of the equator, and in close juxtaposition to the narrow band from which the spots had formerly been evolved (F).

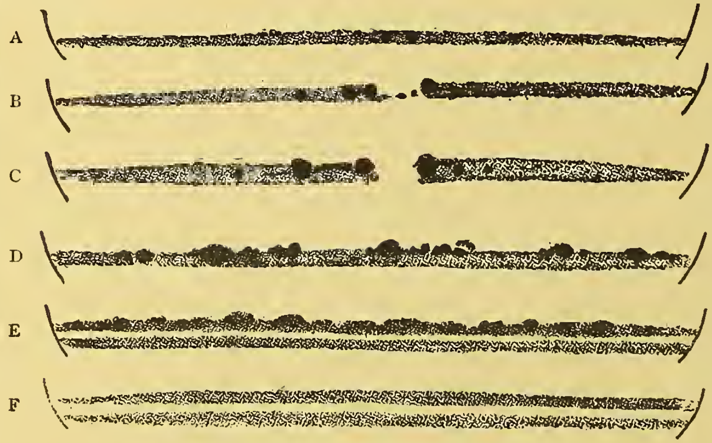


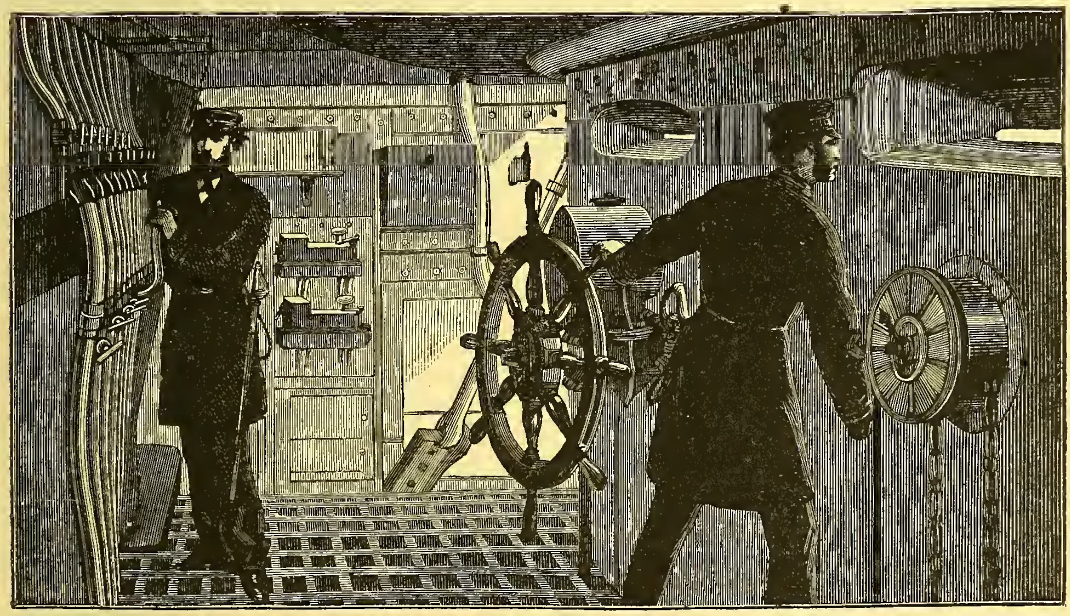
Fig. 3.—GRADUAL FORMATION OF A NEW BELT.

The stupendous forces which originated so extensive an outbreak, and the wonderful phenomena which subsequently led to its development into a new belt, can hardly be conceived. The equatorial diameter of Jupiter is about 88,000 miles, and his circumference more than three times as great, so that we can understand with what remarkable velocity the spots must have accumulated. There can be little doubt that the new belt was evolved from the surface or kernel of the planet, and represented a gigantic escape of probably heated vapour, which, as it mingled with the outer strata of the planet, became distributed by means of his very swift axial rotation. In any case we must conclude that the spots were ejecta or uprushes from the planet, and were not formed above his surface. We see similar phenomena in constant process of repetition in the dark belts which environ his equator. These become fainter at times, but are intensified and re-invigorated by the apparition of dark spots and patches, which sweep rapidly westwards, and lengthen out until they are dispersed amongst the dusky material of the belts. Then the latter assume a darker hue by the reinforcement, but daily grow fainter until another outbreak of spots restores their dark and definite aspect. In a word, the belts of Jupiter simply represent the material of confluent eruptions of dark spots and masses, which are ejected from the surface and spun or woven into longitudinal streams by the effects of the planet's very rapid rotation. The velocity of an object on the equator of Jupiter is equal to 467 miles per minute, whereas for an object on the earth it is only seventeen miles per minute. This marvellously swift motion must be sufficient to originate the phenomena alluded to; indeed, any one who makes a special study of the telescopic features of this planet must admit that their forms and disposition on the Jovian disc prove them to be influenced by a series of swift currents, brought about by the great axial motion of the planet.

As to the bright bands of Jupiter, they probably represent highly-reflective clouds, somewhat analogous to those of our own atmosphere. Below this there is probably a much denser strata, and nearer again to the surface we may conclude, according to Mr. Matthieu Williams, that there is a layer of heated and condensed gases; while surrounding the kernel of the planet is a profound ocean of denser vapours, and of such volatile metals and minerals as may exist on Jupiter. The body of the planet is red-hot, or rather white-hot. Extravagant and chimerical as this theory may be to some, it is consistent with many observed facts, and seems to be the most plausible conclusion at which we can arrive as to the present condition of the planet.

OUR IRONCLADS.

It is quite obvious that the idea of armour being applied to the outside of a vessel could not in the nature of things be a very original one. The use of armour by the individual was of very ancient date, and the transfer of a similar protection to the sides of a ship would be as natural as the plating of doors in old castles—a practice of singular antiquity. So also with regard to rams: the principle of ramming or butting an enemy, whether a ship, a castle, or a wall, belongs to the very early ages of war. Notwithstanding, however, these general resemblances to something which was the common property of our ancestors, there is still room for reasonable astonishment and interest in the developments which have taken place in the normal idea, and it is that to which we are about to call attention. The original element in the matter is that in the old system the vessel was all in all; the weapons of offence and the arrangements for defence were subsidiary in a certain measure to the necessities of the ship as a ship. At the present time, in naval architecture the ship *per se* is nothing: all is subordinated to her aggressive and defensive powers. The poet has described a ship as "walking the waters like a thing of life." As a matter of fact, the ironclads have neither symmetry nor picturesqueness, or any attraction whatever to invite poetic description; what they have is a particular and exact adaptation to the purposes of destruction, coupled with the faculty of resistance in the highest degree.



STEERAGE-ROOM OF H.M.S. "INFLEXIBLE."

The Norman freebooters arranged their bucklers alongside the vessels, and various plans were adopted to protect the sides of their vessels in engagements. As early as the twelfth century they were in the habit of putting a belt of iron around their ships, just above the water-line, the belt terminating in front by a spur. The Spaniards, in 1304, had the sides of their vessels covered with raw hides, to protect them from incendiary attacks; at the battle of Lepanto, in which the celebrated author of "Don Quixote" took part as a private soldier, the Genoese ships were strengthened by blindages, or bulwarks, composed of old sails, cordage, heavy beams, &c. Coming down to a later period, in 1782, at the unsuccessful siege of Gibraltar, the Chevalier d'Arcon, at the suggestion of M. de Verdun, constructed and used ten floating batteries, having their tops bomb-proof, and the sides protected by parapets six feet thick, composed of hard wood, reinforced by cork, leather, and bars of iron. The batteries themselves carried 214 guns of large calibre, of which seventy-two were reserves. Although no success attended the expedition, yet for several hours at close range these ships withstood a tremendous artillery fire concentrated upon them from the forts; eventually they were all burnt or blown up, having yielded to red-hot shot. In 1826 an anonymous writer in Paris proposed the construction of ironclad frigates, the walls of which should have a thickness sufficient to resist cannon ; this was with direct reference to Colonel Paixhans' system of horizontal shell-firing, "because," the writer contended, "wooden ships would no longer be of any use." Colonel Paixhans, the inventor of the guns which were to do so much mischief, himself recommended, in 1841, the plating of war vessels, so as to resist his own system of artillery; but his proposals, ingenious and expedient as they were, did not then command the acceptance of the French naval authorities.

In 1854, the American Government commenced some experiments in the construction of iron batteries ; one feature in their then system was the use of inclined instead of vertical plating, so as to change the direction of the enemy's projectile after impact. The iron plates consisted of 3½-inch iron slabs laid on triangular backing of timber, extending in their length four feet below water-mark. From the outer edge of this side protection, the shot-proof casemate proceeded upwards and inwards at an angle of 1 vertical to 2 horizontal, and to a height of 28 feet from the bottom of the ship and 5½ feet from the fighting-line.

The authorities at Woolwich, and also the French Admiralty, tested the theory and design of this vessel. The Emperor of the French (Napoleon III.) acting on the plans of M. Guieysse, directed the use of iron plates 4½ inches thick, an elastic backing of oak of 8 inches, and plates rolled to the required thickness, instead of a variety of plates considerably thinner united together. Five floating batteries were so constructed, 160 feet long, 42 wide, 8 feet draft. The armament consisted of ten 50-pounder guns under the cuirass and two 12-pounders on the forecastle. These improvements in the French navy caused immense excitement in England, which some of our readers may be old enough to remember. The French Minister of Marine sent plans of these vessels to the English Government, and eventually the latter ordered five batteries to be made of the new type. They were merely batteries, and had no merits as ships. These French vessels proved themselves in the attack on the Russian forts of Kinburn so as to satisfy the most sanguine expectations of their architect and of the Government.

The building of the *Gloire* at Toulon, in 1858, distinctly marks a new era in naval artillery. She was to carry 36 guns of 6·3 calibre ; her side plates 4½ inches thick, backed by 24 inches of timber. From that date every improvement in artillery has been met by a corresponding improvement in the naval armoury. In England, it has been said, the building of the *Warrior*, the *Defiance*, and the *Black Prince* was a practical answer to the French activity, just as at the present moment the building of the *Camperdown* at Portsmouth, on the *Admiral* type, is an answering move to the boastful ship-building of the Italian Government.

Our earlier ironclads were of two types ; now they are various. Originally there were those in which the walls were protected by plates laid on the walls of the ship, such as the *Warrior*, the *Achilles*, and the *Bellerophon*, and those carrying their batteries in turrets, such as the *Minatonomah*, the *Minotaur*, the *Glatton*, the *Thunderer*, and the *Devastation ;* and these in turn were subdivided in a rough fashion, according as their uses were for cruising, defending harbours, &c.

There are some curious gradations to be marked in this subject. The universal introduction of rifle fire-arms rendered rifle artillery a necessity, for if the small weapons exceeded the large ones in precision and range, the gunners working the guns would be killed by the bullets of the rifleman's fire at a distance beyond the range of the heavy guns. Then the general introduction of rifle guns of heavy calibre rendered it, in turn, indispensable that ships should in some way be protected from large projectiles and their augmented power and precision. Hence each development was a necessary consequence of the preceding one ; it followed also that the simplicity which would be sacrificed in the construction of our guns would have to be sacrificed in an equal degree in the construction of our new ships ; and whilst the guns required more manipulative skill on the part of the gunners, the ship would also require a new quality of intelligence (that of the engineer) on the part of those who worked her.

Since the construction of the *Warrior* the changes in structure, in armour, and in armament have been, and continue to be, so varied that the description of to-day may be obsolete to-morrow. One of the first ironclads constructed, and now afloat, was 380 feet long, breadth 58 feet, 6,170 tons, engines 1,250 horse-power, with bunkers that held coal for nine days' steaming. She carried originally thirty-six 68-pounders and two 25-pounders. The armour might have appeared, at a superficial glance, mere thin plates of tempered steel ; but if you had examined these during construction, you would have been surprised to find slabs of iron 4½ inches wide, backed with 21 inches of teak, whilst the inner skin was of half-inch iron. Between decks there were ponderous iron doors, which ran across on slides, and could be bolted on the inside if the boarders got possession. These were found at each end of the vessel, so as to turn it on an emergency into a shot-proof fort.

The *Inflexible*, a much later vessel (1874), had unarmoured ends. She is a turret-ship of the citadel kind, the turrets being amidships. The central division of the hull is heavily armoured beyond its limits fore and aft; the vertical armour plating is succeeded by the horizontal shot-proof deck, so that the shot hop off it like raindrops from a cabbage-leaf. The citadel portion, situated amidships, is (on the lower deck) divided into boiler-engine and boiler compartments. The turrets are not facing each other (so to speak) on the deck in the centre of the ship, but placed diagonally, so as to give a wider horizontal sweep to the two guns on each side. From the accompanying illustration of the steerage and turning gear, an idea may be formed of the thickness of the walls and the thorough protection enjoyed by the "man at the wheel."

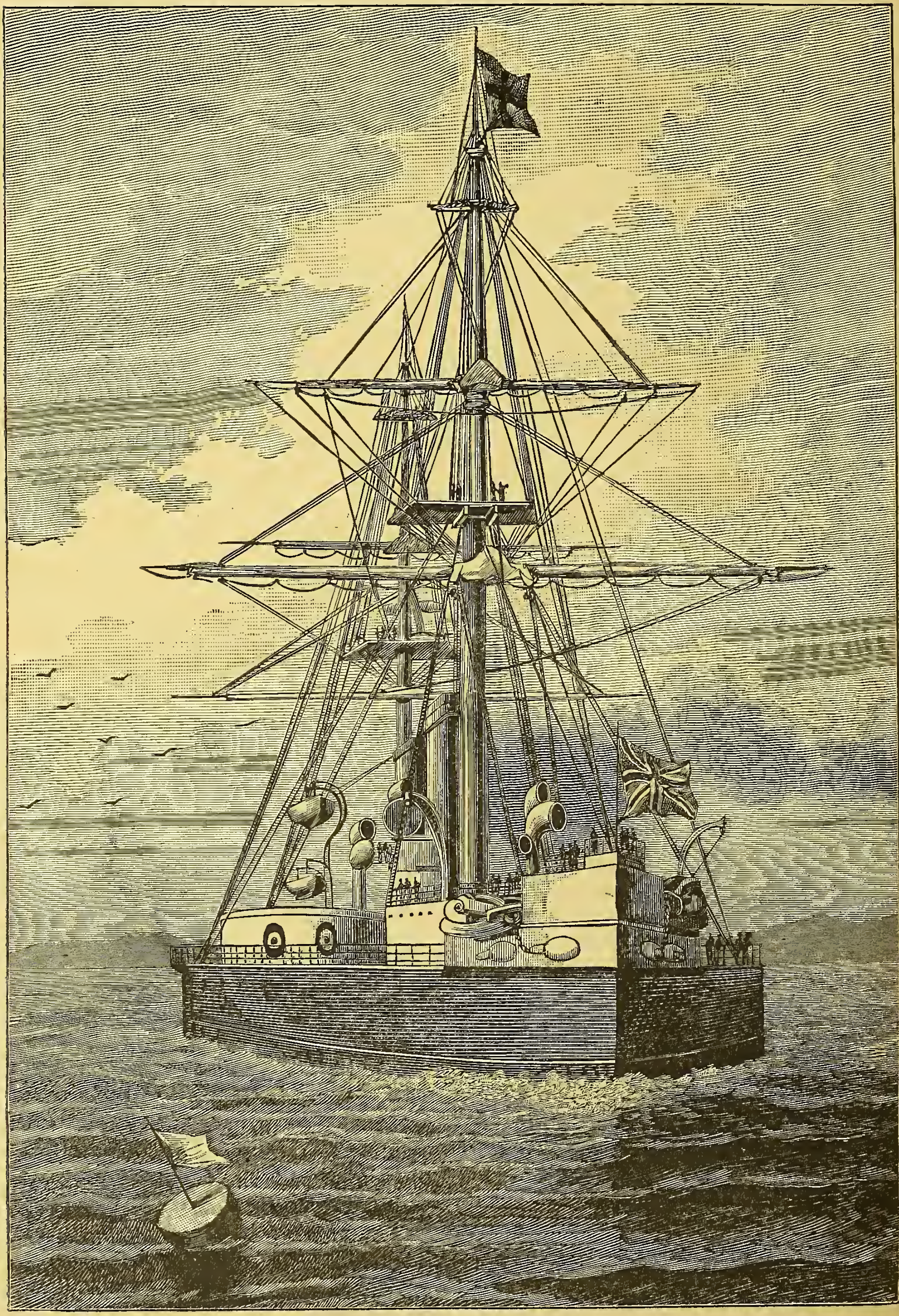
The *Camperdown*, now under construction, will differ from the *Inflexible*, and, indeed, all her predecessors, and will be considerably larger than the Italian *Duilio*. She will be propelled by twin screws, and will be of 9,800 horse-power. She will carry four 63-ton guns and six 6-inch guns, besides machine guns and torpedoes. Her bunkers will hold 900 tons of coal.

In connection with the recent operations before Alexandria, it will be interesting to know the architectural types of the different ironclads. The largest vessels of the earlier type are the *Warrior*, the *Hercules*, and the *Minotaur*; the smaller vessels of the earlier type, the *Hector* and *Resistance*. The largest recent masted vessels, the *Monarch*, *Hercules*, the *Sultan*, *Alexandra*, and *Temeraire*; smaller masted types, the *Vanguard* and the *Triumph*; belted ships, the *Shannon* and the *Nelson*; mastless, or lightly-rigged, the *Devastation*, *Dreadnought*, *Inflexible*. Rams, the *Hotspur* and the *Rupert*. Minotaurs, the *Gorgon* and *Glatton*. All these vessels are constructed in water-tight compartments, and the *Achilles* has no less than 106, the *Alexandra* 115, and the *Inflexible* 135.

In the construction of these vessels due regard had to be paid to the character of the materials. Apart from the actual experience of their manner of behaviour in action, drawn from the lessons of the American civil war, the authorities have been able, by constructing targets which shall correctly represent the sides of an armour-plated ship, to ascertain the adaptability of iron, steel, and timber, and their relative power of resistance to the various missiles which can be used against them at various ranges. Compound armour-plates are those now in favour. With respect to the thickness of the armour, great changes have already been seen. Nine-inch armour at the water-line was considered the desirable maximum, and 6 inches on the remainder; then we had 10-inch teak backing, with longitudinal girders at intervals of about two feet, working upon 1½-inch section plates, supported by 10-inch vertical frames placed two feet apart, the space in between being filled with teak; inside the frames a further thickness of 19 or 20 feet of teak; the whole being banded on the inside with ¾-inch iron plates, stiffened with 7-inch frames; the total thickness of iron is 11¼ inches, of which 9 inches are in one thickness. The armour of the new ironclad, the *Camperdown*, to which we have already referred, will reach to a depth of five feet below the water-line, and she will be protected by a belt rising two feet six inches above the water-line. Her armour will consist of compound plates: on the side, 18 inches; bulkheads, 16 inches; barbettes, 14 inches and 12 inches; conning rower, 12 inches and 9 inches; and screw bulkheads, 6 inches. She will differ from all existing types, armoured or unarmoured, in having vertical ventilating tubes extending from the flying deck to the lower deck; these tubes are armoured to the thickness of 12 inches. She will be also protected by an armoured deck, 3 inches thick over the belt, and 2½ inches thick below the water-line at the ends.

It is contended by some persons that it is a great advantage to our navy to have vessels possessing different characteristics and fighting capacities; thus we have from the 4¾-ton guns of the *Warrior*, 9, 12, 18, and 25-ton guns of the *Monarch* and the *Glatton*, whilst the turret-ship *Devastation* has a 30-ton gun. The turret or *Minotaur* class of vessel, however, marked a distinct epoch in naval architecture, and it needs a few words. This vessel was constructed by an American engineer, named Ericsson. She had a revolving turret, composed of wrought-iron plates an inch thick, and belted together until a thickness of eight inches had been obtained. The turret was 20 feet in diameter, 9 feet high, and contained two 91-inch Dalghren guns, trained side by side, and revolving with the turret. The hull was of iron, 127 feet long, 36 feet 2 inches wide, with a 12 feet depth of hold. She was built in 1862, in the short space of 100 days, and cost 275,000 dollars, or about £55,000. The advantage of the turret-ships is the facility which they afford for training large guns smoothly and easily through large arcs, giving a large range of horizontal command, and making the same guns available for both sides of the ship. The turret system describes itself: the gun or guns revolve in a turret, in precisely the same manner as a railway truck is made to revolve upon a turn-table; the great drawback which they have to contend with is the weight of armour. With a given weight it is practicable to mount eight guns on the broadside principle, four and four, and to work them as effectually as four guns only, mounted in two turrets; it is, of course, more desirable to have four guns on each side, two firing simultaneously, than to have only four altogether. The Americans have a method of mounting guns in pairs at broadside ports.

How long the international competition in the construction of these vessels may continue it is



H.M.S. "INFLEXIBLE."

impossible to say. To the scientific development of the system there appears to be hardly any clear limit; probably the financial necessities imposed upon governments will be the practical limit to this system of competitive armament. In England we have within the last few years unreluctantly expended upwards of £10,000,000. The *Achilles* cost £484,311, the *Bellerophon* cost £487,738. Twelve ironclads, including those of the types named before, cost, in actual labour and materials, and no one can tell what developments of defence the gradual improvements in artillery may render necessary. But England has least cause of any power to be anxious about this. No other power has made such indefatigable efforts, nor expended ungrudgingly such vast sums in tentative constructions, as the English Government, supported by the public spirit of a people proud of their maritime supremacy. Our reward is the possession of the most formidable navy the world has ever seen.

1 2 3 4

JAPANESE DWARFED TREES.

£3,438,345, and if 12½ per cent be added to this as establishment charge, we get the astonishing total of about £3,500,000. The *Invincible* was a contract-built ship. The *Inflexible*, of which we give an illustration from perhaps her best point of view, and which did such good service during the bombardment of Alexandria, is a type of the "mastless sea-going vessel," built in 1874; she cost £484,000. Her displacement is 11,400, horse-power 8,000, length 320 feet, breadth 75 feet.

The rivalry between guns and armour seems likely to continue. Year by year, almost, guns are made capable of piercing thicker and thicker armour, or of penetrating it at a greater distance;

JAPANESE DWARFED TREES.

PERHAPS no people are more remarkable than the Chinese and Japanese for the minute care and attention which they bestow upon their agricultural undertakings. This is not only the case as regards the production of cereals, pulses, and other useful plants, but they devote not a little care to purely ornamental cultivation, and especially delight in the production of quaint and abnormal growths. The old Swedish traveller, Thunberg, for instance, describes the beauty of the Japanese flowering almonds and peaches, which, as well as plum, cherry, apple, and pear trees, were covered with a mass of double and single blossoms, of the former of which the Japanese were particularly proud.

Both in Japan and in China it is the custom to produce dwarf fruit-trees, such as have of late years become not uncommon in our own green-houses, while in many of the houses in Japan may be met with tiny specimens of the orange-tree, which are seldom above six inches in height, and bear oranges only of the size of a cherry, "and yet sweet and palatable."

Distinguished as they are by what we should consider the grotesque in art, they are, also, remarkable for the strange liberties which they take with the natural growth of plants, not only producing, by clipping, those hideous monsters in the shape of dragons, serpents, lizards, and the like, of which the counterparts might to some extent be seen in England about a century ago, but actually altering and retarding their normal development. In this art of producing monstrous growths in plants the Japanese excel all others, and by their mode of treatment induce such strange results in the forms of their victims as to leave them hardly recognisable as the things they are.

How these results are obtained appears now to be tolerably clear. The production of dwarfs is indeed based upon one of the commonest principles of vegetable physiology, namely, the retardation of the flow of sap in the young trees. Where the dwarfs are raised from suckers, as is frequently the case, the main stem is in most cases twisted in a zigzag form, which at once checks the free circulation of the sap, and at the same time promotes the growth of side branches at those points of the stem at which their production is most desired. But should the branches, thus encouraged, fail to grow symmetrically, the labour of the arboriculturist will have been thrown away, for neither by the Chinese nor by the Japanese is a one-sided dwarf tree considered of any value. When the trees are raised from seed, those seeds are selected which are themselves the smallest, and which have been gathered from the smallest trees. The supply of water is reduced to the smallest possible quantity, and as new branches are in the act of formation their growth is retarded in various ways, the points of the leaders being generally nipped out, while every means is adopted to prevent the production of young shoots possessing any degree of vigour. Doubtless, too, those plants are selected for the purpose which lend themselves most readily to the operation, and are capable of retaining their vitality under the most adverse conditions. Nearly all the vegetable monstrosities are dwarfed in size, and consequently must to no inconsiderable extent have been deprived of requisite nourishment, and in some cases almost of the absolute necessities of life. Added to this, they are frequently further modified in form, the branches being bent and intertwined, or tied together in order to force them into some unnatural and grotesque position. By this means the appearance of great age is often imparted to comparatively young plants, while by the simple process of dwarfing a semblance of sickly youth is preserved, even when the plant has reached a considerable age. It is possible that the climate of Japan favours to some extent the growth of plants under these most unfavourable conditions; and probably in countries colder, more arid, and more isolated, the production of such monstrosities would be attended with much greater difficulty. Still, there can be no question that both the Japanese and the Chinese are gifted with special skill in this branch of arboriculture, and indeed can hardly be said to have any competitors in the art.

The English botanist, Fortum, in his travels in China and Japan, had frequently an opportunity of admiring the skill and knowledge with which their singular gardening was performed. Of Japan he writes as follows :—"As the lower parts of the Japanese houses and shops are open both before and behind, I had peeps of their pretty little gardens as I passed along the streets, and whenever I observed one better than the rest I did not fail to pay it a visit. Many of these places are exceedingly small, some not much larger than a good-sized dining-room; but the surface is rendered varied and pleasing by means of little mounds of turf, on which are planted dwarf trees, kept clipped into fancy forms, and by miniature lakes, in which gold and silver fish disport themselves." Among the plants which he noticed in these tiny plantations were azaleas, pines, junipers, some ferns, and a pretty little dwarf variegated bamboo. These little gardens, with their dwarfed, but well-tended plants, belonged for the most part to the poorer classes, but in the outskirts of the larger towns plantations of greater extent may be occasionally seen, the property of the wealthy nobles. In these, however, the dwarfs are by no means absent, while here and there may be seen a giant of its kind, amongst which may be mentioned a huge azalea, which measured no less than forty feet in circumference, and must, when in flower, have presented the most magnificent appearance.

It is upon the conifers (pines, firs, &c.) that the Japanese chiefly exercise their ingenuity in the production of these monstrosities, the pines being apparently the best able to withstand the effects of such unnatural treatment. In the figure (Fig. 4) is represented a dwarf pine (*Pinus densiflora*), which is known to be certainly a hundred years old. The pot in which it is contained is but 19½ inches in diameter, and is completely filled up by the growing stem. Notwithstanding its age, the dwarfed tree reaches in height only 47 inches, and though to all seeming healthy, will probably never attain to any much greater development.

Another example of the very remarkable results obtained upon vegetable growth by the abnormal treatment practised by the Japanese is that shown in Fig. 3. Here the trunk of the dwarfed and misshapen tree (also *Pinus densiflora*) appears suspended in mid air, while the long bare roots, supported by props, and here and there tied to keep them in the desired position, at length reach the earth, whence they draw up the nourishment requisite to sustain the life of the diminutive tree. In this example it is not easy to distinguish the root of the pine from the stem, nor to tell where the one terminates and the other begins. Though at least forty years old, the total height of the plant, including the bare suspended roots, did not exceed twenty-eight inches.

In Fig. 2 is shown a young pine (*Rhynchospermum japonicum*), perhaps ten years of age, which was brought to the Paris Exhibition of 1878, while in Fig. 1 is another example of a dwarfed and deformed *Pinus densiflora.*

But perhaps one of the most remarkable instances of dwarfed trees of which any account has reached us is that related by President Meylan, who in 1826 saw a box which he states to have been but one inch square and three inches high, in which, nevertheless, were growing a fir, a bamboo, and a tiny plum-tree, the last being thickly covered with blossom. The happy possessor of this vegetable curiosity was willing to dispose of it, but for a sum of no less than one hundred pounds. If the amount of patient labour, and the degree of skill, necessary to produce such a wonder be duly considered, the sum may not appear exorbitant: nay, it may be doubted if such a curiosity of vegetation could be profitably produced for the money.

Though the production of some of the dwarfed fruit-trees already referred to is no doubt advantageous, and is performed more with a view to utility than ornament, the artificial formation of such vegetable monstrosities as those exhibited in the figures can be regarded only in the light of a singular caprice. It certainly cannot be claimed for them that they are ornamental, but there is a quaintness about some of them which is more or less attractive, while it is interesting to see to what extent the direct agency of man is capable of altering the normal growth of trees which, in their natural state of existence, present so uniform a character as the pines. When therefore we see one of these trees with the respectable girth of about five feet, and yet having a height of under four feet, it is an object not only of curiosity but of interest, and leads us to consider what changes, under peculiar circumstances, might be gradually brought about on even our most familiar and common plants.

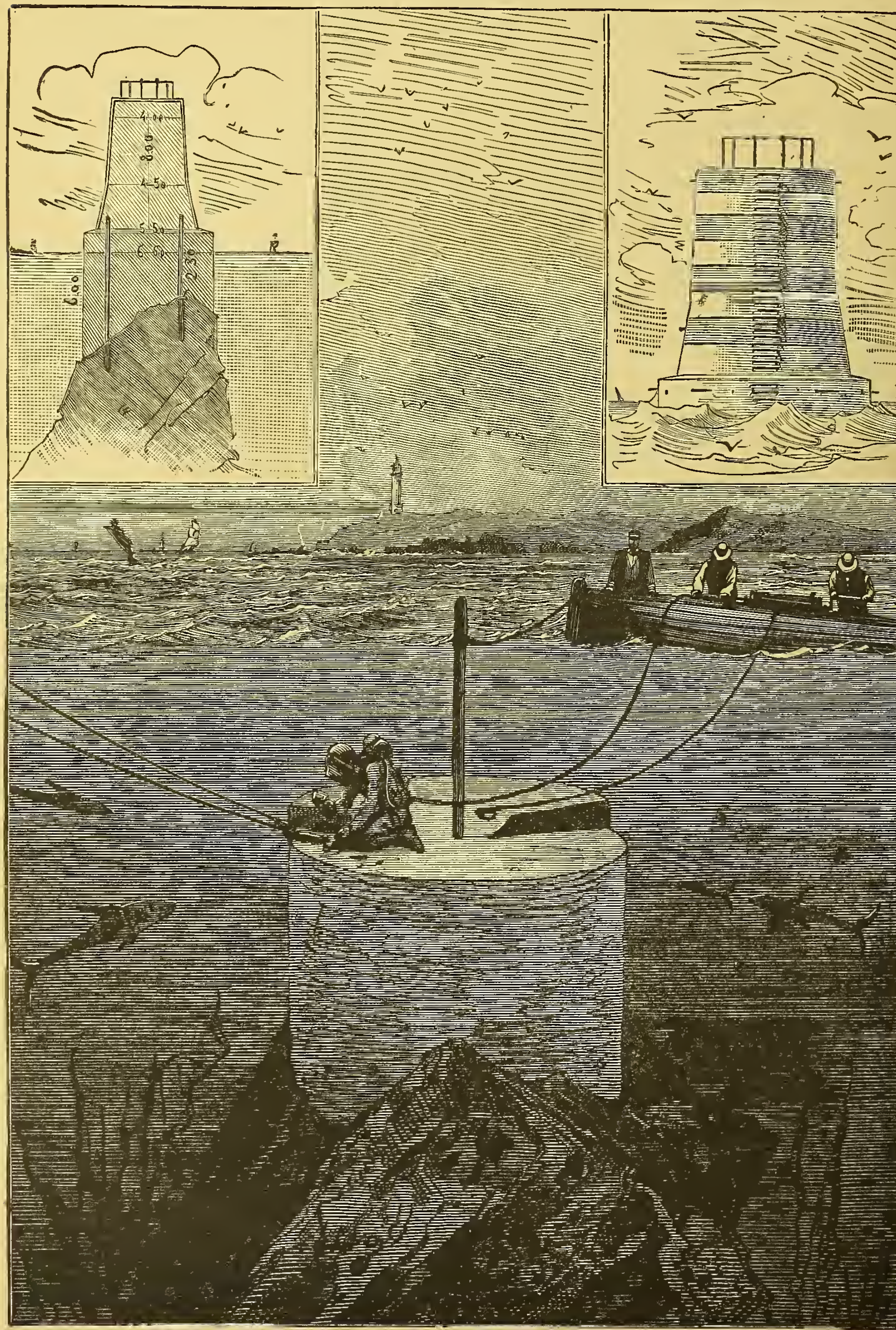
DIVERS AND THEIR WORK.

LITTLE does the world at large know of the perilous undertakings beneath the surface of the sea, so skilfully carried out by submarine engineers. It is not until the imposing superstructure of lighthouse or other edifice rears itself above the waters that the result of their submarine labour is manifest; and too often the readier admiration is given to that which is visible, than to the more perilous and exhausting labours, out of sight, in the depths of the sea.

So great is the cold and exhaustion attending the work of divers under water, even when protected by the best scientific appliances, that the hardiest can work only for an hour or two at a stretch, and but few hours in the day. In many cases bleeding at the nose and ears, deafness, and other ailments, soon supervene, if the work is to be carried on at any considerable depth.

A diver's accoutrements consist of a water-proof suit, rendered water-tight at the wrists by india-rubber, so as to leave his hands free, and his head is covered with a copper helmet, which makes a water-tight junction at the neck and shoulders with his waterproof suit, and which is provided with glass goggles, to enable him to see his work. Any failure in the water-tight character of this suit and helmet would allow the water to enter and stifle the diver. Fresh air for his consumption, when under water, is supplied to the hollow helmet, through flexible tubing, from an air force-pump. This pump is carried on a barge or boat, where it is operated by two attendants. Should this air-tube become entangled, or cut, the diver's life would be again in great danger. The air escapes from the helmet by its own pressure through a waste-valve, which prevents the entrance of water.

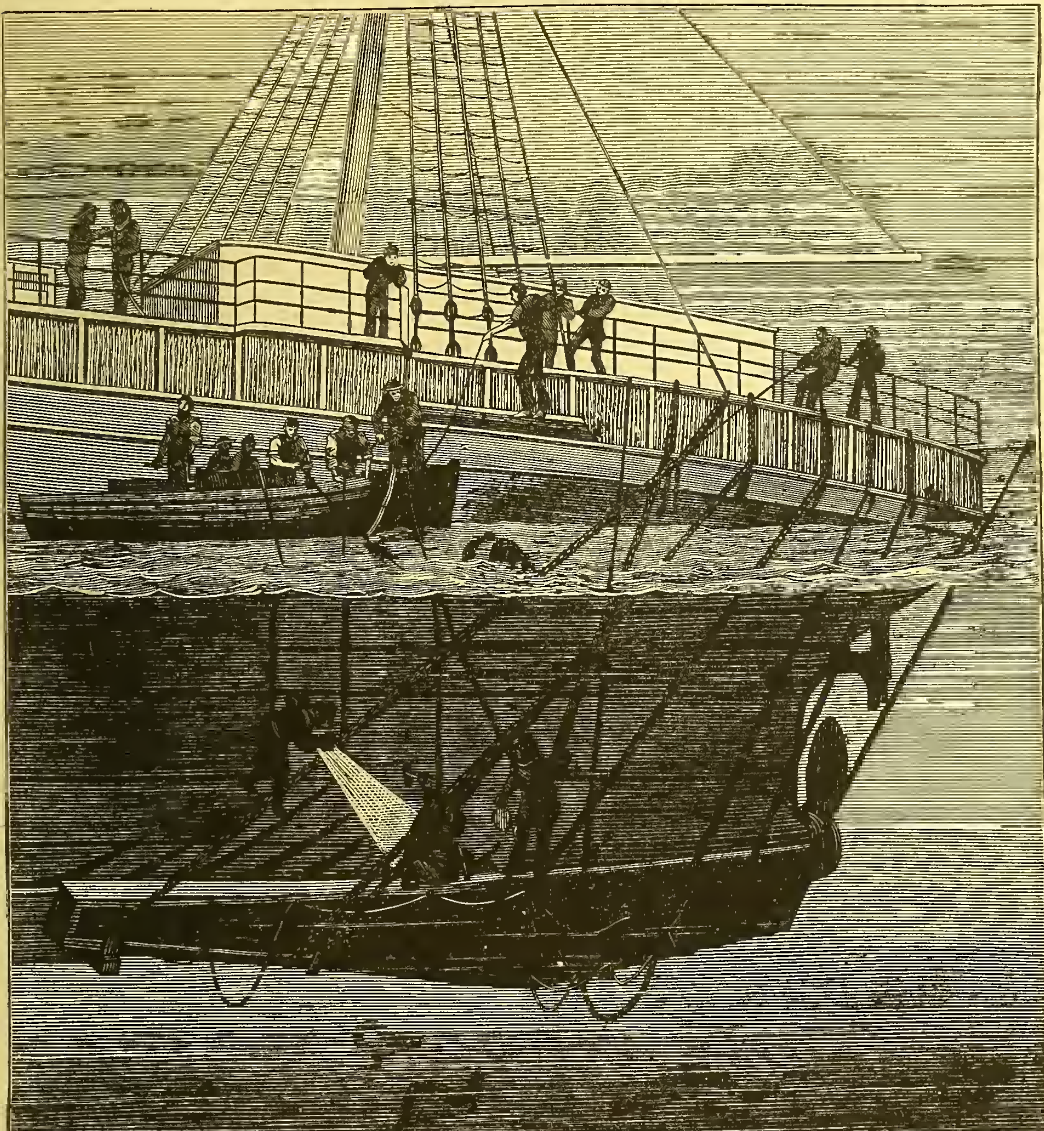
The strangest difficulty that the diver has to face, and allow for, is the buoyancy of the surrounding water. Were he to attempt to descend into the sea without any further appliances than those we have hitherto described, he would not find himself able to descend at all. The human body has nearly the same specific gravity as the water; in fact, a little less when the lungs are inflated, which enables a swimmer to float. As the volume occupied by the air in the helmet of the diver still further diminishes his specific gravity, he would find himself, when in the water, so supported by its buoyancy that he could not get below its surface at all. To overcome this tendency he carries heavy leaden weights, slung over his shoulders and fastened to the soles of his feet, and thus weights himself as if bent on suicidal intentions. These weights present a new element of danger. He is obliged to carefully descend a ladder from the boat, from which he is as liable to fall as if in the air. In the same way, whilst working on the summit of a pinnacle of rock, he is liable to miss his footing



SUBMARINE OPERATIONS AT THE ROCK OF LAVEZZI, IN THE MEDITERRANEAN.

and fall into unknown abysses. Nor can he readily return to the surface in cases of extreme emergency, as his leaden weights nail him to the bottom. The weights are usually so fixed that the diver can

In the face of such manifold dangers does the hardy diver pursue his necessary and valuable work below the chill waters, and sees, no doubt, many wonders in the deep beyond ordinary ken.



SUBMARINE REPAIRS TO THE "COLUMBIA."

readily throw them off in cases of emergency, should he have the presence of mind to do so ; but a new danger may arise even from such a proceeding. Were he incautiously to remove the weights first from his feet whilst those on the shoulder still remained, he would find his feet rise vertically above him, whilst his weighted head would descend to the bottom, and he would thus be rendered more helpless than ever.

The accompanying illustration gives a graphic idea of the submarine operations carried out in the construction of a signal-tower upon a dangerous sunken rock between the islands of Corsica and Sardinia. This rock, known as the Rock of Lavezzi, lies in the centre of the navigable Straits of Bonifacio, between the said islands ; and as it is at low tide some seven feet below the surface, its jagged point forms a dangerous trap not easily discerned. It has been the scene of numerous wrecks. In particular the frightful wreck, in the year 1855, of the French war frigate *La Sémillante*, on board of which were 743 souls, not one of whom was saved, gave it a dreadful notoriety. The Sardinian Government had endeavoured to indicate its position by a floating bell surmounted by six mirrors, which served to reflect the rays of the sun by day, and those of a neighbouring lighthouse by night. Unfortunately, this beacon was destroyed by being dashed against the rock in the very storm when its warning was required, so the government determined to erect upon the rock a plain pillar of masonry, to act as a signal-tower. The upper surface of the rock presented an irregular inclined and jagged circle of about twenty feet in diameter; so the site, which was never uncovered by the water, presented as awkward a base for architectural purposes as could well be imagined. However, engineering ingenuity fitted to the rock a caisson—that is, a cylinder with an interior diameter equal to that of the proposed tower, and without any bottom, the sides being formed irregularly, so as approximately to fit the rock on which it rested, and the upper edge extending some distance above the surface of the water. This was to form a mould, as it were, for the tower. Concrete—that is, a mixture of stones, sand, and cement, was prepared in barges, floating near, and the concrete was thrown into the interior of the caisson to form a base upon which the superstructure could be built. This was successfully effected, and it was hoped that such a heavy mass of solid concrete and masonry would be a permanent fixture upon the rock, and that the rock was done with for the future. A second lighthouse was erected on a neighbouring isle, so that two lighthouses should, from opposite sides, throw converging rays of red light upon this beacon during the night. All was successfully carried out, and the indication of the sunken rock was perfect by day or night, had the signal-tower been able to withstand the fury of the tempest. But it was well that no lives were entrusted to its keeping, as the tower was swept completely away during a furious storm in the year 1875. It had lasted but six years from its commencement.

However, with creditable perseverance, always characteristic of the struggle of man against the forces of nature, it was determined again to build a tower which no storm should be able to remove. The engineers determined this time to secure the concrete foundation by piercing through it no less than thirteen strong perpendicular bars of iron, which were to be sunk some three feet into the rock, thus absolutely pinning the foundations to the rock. In order to save the labour of piercing the holes through the concrete foundation, cast-iron tubes were placed in proper position before the concrete foundation was run into the caisson as before. The surface was levelled off ready for building upon, and the holes were then pierced by plungers or "jumpers" in the hands of divers—as shown in our illustration—through the hollow pipes into the rock beneath. Into these holes the iron bars were inserted, and liquid cement run in to the pipes to fix the bars and make all secure. Upon this foundation was the superstructure built, which was child's play compared with the submarine work. The divers had to go to their work armed with daggers, to defend themselves against the possible attacks of the "squids" and sharks, which are numerous in those waters; and their work could only be carried on from the attendant boats when the weather was fine and calm. They were unlucky in their weather, having no less than eleven tempests in the spring season, allowing them only thirty-six working-days out of one hundred and seventy. No doubt many were the hair-breadth escapes of the party, when fleeing from the rock at the rise of the sudden tempests of the seas. But again has the work been successfully completed, the tower rising some twenty-three feet above the level of the sea, painted in alternate streaks of red and black, to be the more conspicuous. We hope this time that such brave persistence will meet with the reward it merits, in the final immovability of the signal-tower of Lavezzi.

Our second illustration records an equally brave and audacious submarine feat of skill. A serious accident happened to the steamship *Columbia*, of the Compagnie Royale du Pacifique, when on her voyage from Panama to Callao, in July of 1878. She was thrown, in a storm, upon the rocks of the port Ballenita. These rocks, which have jagged points, pierced her hull near the stern, the vessel remaining firmly fixed upon the rocks. When fine weather supervened, the cargo was all discharged, the aid of other vessels was obtained, and she was towed off the rocks to float once more. It was found, however, that the hole pierced in her iron hull was so serious, that no ordinary means were capable of keeping out the water, and so much water entered, that she was soon water-logged at the stern, and that portion of the vessel was almost submerged. Under these circumstances it was impossible for the vessel to continue her passage to Callao, which was the nearest port where efficient aid could be obtained, though distant nearly 500 miles. It must be remembered that at such foreign or colonial ports as Ballenita there are no dry docks, shipwrights, or engineers to give efficient aid to vessels which may have undergone serious damage; and as a rule, vessels once seriously injured, under such circumstances, are irrecoverably lost.

The chief engineer of the company, however, (James Thomson by name, as we are proud to observe), made the spirited resolve that he would take men and temporarily repair her, where she lay in deep water, by the aid of divers. When he and his party arrived at Ballenita, he sent his divers down to ascertain the extent of the damage. The size of the hole they found may be best judged by our readers from the illustration.

Two blades out of four of the propeller and the rudder were broken clean away. However, Mr. Thomson did not despair, but sent down the divers to make a template, or pattern, of flexible laths, of the shape of the ship's hull, clear outside the hole, so as to enclose the leak within it. From this pattern, when brought on deck, the engineer and his assistants made a strong timber box or frame, caulking it securely, to make it water-tight, the edges being fitted by the pattern, so as exactly to fit the hull round the leak. This box was then lowered, and braced into position by strong chains passing round the hull of the vessel, so that it was firmly pressed into the required place. When firmly secured in place by internal clamps, under the direction of the divers, these latter then set to work to firmly caulk the frame all round where it touched the ship's hull.

The protector being thus made water-tight over all its joints and surface, prevented the water from entering the leak. The water from the hold was soon pumped out, and the stern of the vessel began to rise from the water until it regained its proper height. The propeller being found to act fairly well in its broken state, and the rudder being repaired, the *Columbia* started off to complete her voyage to Callao in triumph, where she arrived with perfect safety on the 7th of September. She was kept afloat in that port until the 28th of March following, awaiting her repair-plates from England, when she was docked and put permanently in order. Thus successfully terminated one of the most remarkable of enterprises in ship-repairing in deep water by the aid of divers.

These examples may serve to illustrate the ordinary business operations of submarine diving machinery, such as are more or less carried on almost every day. Recently, however, there have been some special and remarkable developments of the power of remaining under water, and performing various operations in such a situation ; which may serve as the subject for a separate article.

REMARKABLE ANTIPATHIES.

In a previous article we have briefly referred to some remarkable cases of sympathy. It is remarkable that the converse is also the case. Irrational prejudices against certain things are very common amongst all classes and kinds of people, and in their more remarkable and extraordinary developments have puzzled even the most learned philosophers. In some cases such antipathies appear to arise from some peculiar condition of the senses. Amatus Lustianus knew a monk who fainted when a rose was shown to him, and while that flower was in bloom was afraid to quit his cell. The celebrated physician Peter d'Apono could not endure the smell of cheese, and fainted when it was put near him ; and there is still, we believe, in existence a treatise on this subject, called "De. Aversione Casei," written by Martin Schoockms, a professor of philosophy who also possessed this singular antipathy. Scaliger mentions one of his relations who could not look at a lily, and Montaigne mentions some men who had more dread of apples than of musket-balls. The brave and daring Duke of Epernon swooned with terror at the sight of a leveret, although he could look at a hare unmoved. Cæsar d'Abret could not sit at the table on which a sucking-pig was placed, unless, curiously enough to add, its head had been previously removed. Deslandes relates other instances as extraordinary in the *Mercure de France*, one of which was that of a soldier who turned faint whenever linen was cut in his presence. Thomas Hobbes had such a terror of darkness at night that if left in it without a light he would swoon. Tycho Brahe grew sick with terror at the sight of a fox or hare. Bayle was seized with convulsions when he heard the noise of water falling from a rain-spout. Zimmerman mentions a lady who would shudder at the touch of silk, satin, or the velvety skin of a peach. Boyle has placed on record the case of a man who had so powerful a dislike of honey, that when it was introduced without his knowledge into a plaster that was applied to his foot he immediately detected it and insisted upon its removal. Julia, a daughter of Frederick, King of Naples, could not taste meat without experiencing dangerous consequences. Scaliger turned pale at the sight of water-cresses. Erasmus became feverish when he smelt fish ; Henry III. of France swooned at the sight of a cat, and Marshal d'Albert at the presence of a pig.

Mr. J. C. Millengen, M.D., mentions the curious antipathy of a clergyman, who fainted whenever a certain verse in Jeremiah was read ; and says, "I lately dined in company with a gentleman who was seized with symptoms of syncope whenever a surgical operation or an accident was spoken of. St. John Long's name happened to be mentioned, and he was carried out of the room. I have also known a person who experienced an alarming vertigo and dizziness whenever a great height or dizzy precipice was described, such as Edgar's description of Dover cliff in *King Lear*.

SOUND IN COLOURS.

It has been explained in the article on the Phonograph (page 67) how the waves of sound, impinging upon a thin plate or membrane, set the latter vibrating; and that such vibrations, if reproduced from impressions taken from them, can actually render back the original sounds to the ear. In a future article upon the Telephone we shall see how the vibrations of a thin plate, produced by sounds, can also reproduce them in another way. But neither of these machines give us any clear idea of how complicated these sound-vibrations in a stretched plate really are. We should be much mistaken did we imagine that the middle of the plate, bearing the style of the phonograph, simply moved to and fro, dragging the rest with it, as when a drum is beaten in the centre of the parchment. The net actual movement of the style is the result of most complicated vibrations, more analogous to Chladni's sound-figures on plates strewn with sand. They can, however, be best studied by optical means; and one of the easiest methods of doing so is to examine the vibrations in a soap-film.

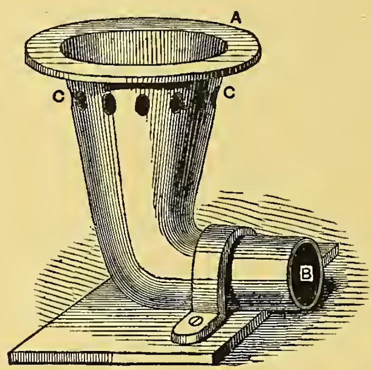


Fig. 1.

Every one knows the exquisite colours displayed by a soap-bubble. These are due to the waves of light reflected from the top surface of the soap-film, and others from the bottom (which have got twice the thickness of the film behind the others), interfering with each other. As the wave-lengths at one end of the spectrum are nearly double those at the other end, these interferences destroy some colours more than others at each thickness ; but all we need trouble ourselves about here is the fact that the colour depends upon, and changes with, the *thickness* of the soap-film. A common soap-bubble soon breaks ; but by dissolving a quarter of an ounce of very pure Marseilles soap in ten ounces of distilled water made hot, and mixing with the solution seven and a half ounces of pure glycerine, a mixture is obtained which, when well shaken, left to settle, and afterwards filtered clear in a cool temperature, will blow a bubble a foot or more in diameter, and last with ordinary films a very long time. Such a solution will readily stretch a flat film over a wire ring dipped in it; or the edge of a card dipped in it, and passed over a hole in a flat plate, will stretch a soap-film over that. Having such a solution, we want some apparatus with which to observe the film, which is usually termed a Phoneidoscope, both the apparatus and the phenomena being based on the experiments of Mr. Sedley Taylor.

A very simple and good form is shown in Fig. 1, where A is an open funnel-shaped tube with a flat ring joined to its upper edge, on which to lay the plates. Under the ring, round the top, holes (C C) are pierced to allow air to escape, without which the film soon bursts. The aperture at top may be from one and a quarter to two and a quarter inches diameter ; at the bottom contracting to an elbow, whose outside aperture (B) may be from three-fourths of an inch to one inch diameter, the whole being fixed on a flat piece of wood as a base. On the elbow (B) is stretched a piece of vulcanised india-rubber tubing, at the other end of which is an ordinary speaking-tube's open mouthpiece of wood. There are further required some plates of metal, each having in the centre a hole either square, round, or some other

Fig. 2.

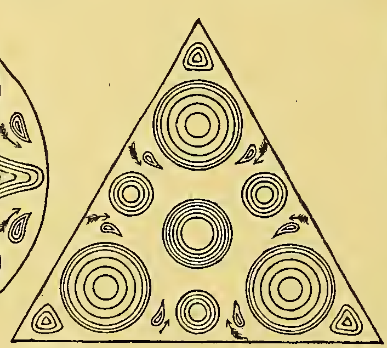


Fig. 3.

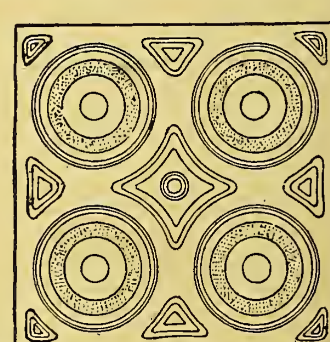


Fig. 4.

shape; hexagons and triangles give fine figures. The holes should be slightly bevelled, or larger at one side of the plate than the other, and the plates should be blackened for contrast. Thick cards will do very well if cut through with rather a slanting cut with a sharp knife, and well varnished and blackened before using. The holes should be a little smaller than the open top of the funnel.

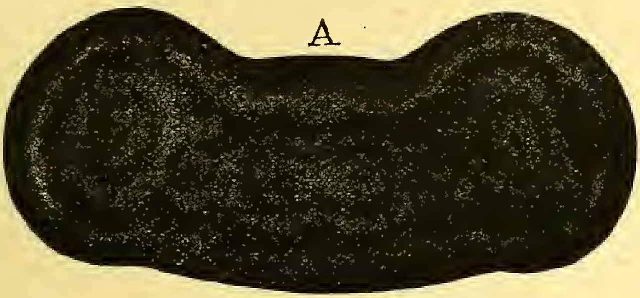


Fig. 5.

Dipping the edge of a card in the solution, one of the holes is now stroked over with it on the smallest side of the hole, thereby covering it with a soap-film. This is held upright till coloured bands begin to show, when the plate is laid—solution downwards—on the ring; and the tube connected with the elbow being taken in hand, the mouthpiece is sung into. It must not be *blown* into, or the film will soon break; but, holding it a little away from the lips, merely the sonorous vibrations of the voice should enter. The apparatus must be where the light from a window or other source may fall on the film, and be thence reflected to the observer's eye. At once it will be noticed that the exquisitely thin and elastic film is thrown into the most complex vibrations, of intricate or simple patterns, connected with the shape of the hole more or less; but it will soon be seen that with each change of note, or even change of vowel on the same note, the pattern somewhat *alters*, even with the same film on the same hole. The general nature of some of these beautiful patterns is shown in Figs. 2, 3, 4, taken from Mr. Taylor's communication to the Royal Society. These figures were, however, actually obtained by him in another way, which may also be employed.

It is common for students of acoustics to mount the leg of a tuning-fork in the top of a box open at one end, of such a length that the column of air within corresponds in pitch with that of the fork. This is called a resonance-box, and by it the sound of the fork is much increased. Mr. Taylor turned one of these boxes with the open end upwards, and the fork projecting horizontally. The plate with the soap-film was then laid on the open end, and the fork strongly sounded by bowing with a violin-bow. The three figures shown were produced in this way; but we have seen the square one exactly reproduced by singing into the tube of the Phoneidoscope in the manner previously described. The film is, however, not only divided into very perceptible ridges and furrows as it vibrates, but it will readily be understood that these different states of vibration tend to thicken or to thin it in different parts. But a difference of thickness involves in a thin soap-film a change of *colour* also; and hence these sound-vibrations produce geome-

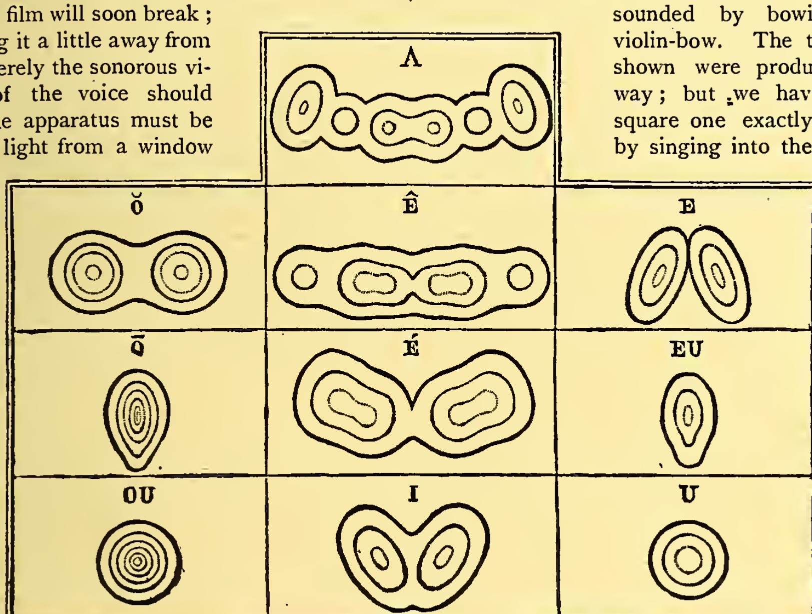


Fig. 6.

trical patterns in different colours. Portions of some of these patterns often consist of whirling pools or vortices, arranged symmetrically and in constant motion ; but the effects are endless, varying, as already said, with every change in the note or word sung into the speaking-tube, and so transmitted to the under side of the film. The sound of a musical instrument, if sufficiently powerful, and concentrated by a cardboard cone into the mouth-piece, will produce varying patterns in the same way. A very brief study of these exquisite and varying figures will make it comparatively easy to understand how the vibrations of a simple thin flexible plate, in Phonograph or Telephone, can reproduce the most complicated forms of speech.

It is even possible to show in this way how the vibrations of one film can be conveyed to another. With all the care possible, the film will burst pretty frequently with an open mouthpiece ; and for lengthy experiments it is better to make one almost exactly like that of a telephone. This has an opening for the lips, and after contracting to a comparatively small hole, expands again into a sort of chamber, across which is stretched the vibrating plate. Where the iron plate would be in a telephone it is sufficient to stretch a sheet of bladder, a film of thin mica, thin india-rubber, or even a piece of paper. Such a mouthpiece does not allow any blast of air to enter at all, but simply transmits the vibrations from the film enclosed in it. Yet the effects are just the same, except that the soap-film lasts much longer.

Sounds thus "drawn in colours," however, beautiful as they are, depend much for their patterns upon the shape of the aperture on which they are displayed. Another method of observing them, discovered by M. Gebhard, is free from this limitation, and requires still less of apparatus. All that is required, in fact, is a saucer full of mercury, tolerably pure. When the thin film of oxide and dust which rapidly forms on the surface is removed, by lightly scraping over with the edge of a dry card, a brilliant mirror-like surface appears for a short time ; and when this is breathed upon, a brilliant series of coloured bands, more or less approaching the character of "Newton's rings," is at once seen, due to the thin film of moisture, whose two surfaces act upon the light by interference in the same way as a soap-film. Anything that alters the thickness modifies the colour ; and since heat rapidly promotes the evaporation of the condensed breath, if the image of a nearly invisible Bunsen-burner flame be focussed on the mercury, the flame-figure will at once be seen, disturbing the previously almost circular form of the rings.

But what we have to do with here are the phoneidoscopic effects. To obtain these the vowel sounds must be sung pretty clearly for several seconds, at only two or three inches from the surface of the mercury, but as naturally and with as little constraint as possible, bending the head a little forward. A few trials may be necessary, some people being much more awkward at such experiments than others ; but with a few trials in different tones, and at different distances near the mercury, the figures will soon appear ; and being thus formed independent of any boundary edge, the same general figure for the same sound will be found preserved with wonderful constancy. Fig. 5 gives the general effect of the French sound for A (English *Ah*) ; and in Fig. 6 M. Gebhard gives the constant figures for the principal vowel sounds according to the French pronunciation. The complicated figure for A (*Ah*) is very noticeable, and very singular, and corresponds well with the complicated sound which the student can discover in the voice.

Another very curious thing about these figures is, that the pattern is found to depend scarcely at all upon the shape assumed by the lips. By practice many vowels can be pronounced with the lips in widely different positions, such as with a circular orifice, or with the lips forming a thin slit; and one ignorant of the subject might have supposed that this chiefly governed the figure. But it is not so ; however the lips are shaped, the figure is almost exactly the same for the same vowel, showing that it is the true *sound* vibrations which determine the matter. The only thing to observe particularly is, that if the vowel be sung too gently, or too far off, its formative power seems rapidly converted into general vibrations of the air, and only such circular rings result as may be obtained from simple breathing.

More complicated sounds of speech may also be studied by this method, though less readily than the vowels ; but it is no part of our purpose to go into any detailed analysis of the sounds of the human voice. It has only been attempted here to give some general idea of one of the most beautiful discoveries in modern scientific experiment, and of the simple means by which any one can see for himself sound—or, more correctly, the vibrations of sound—literally written down or drawn in all the colours of the rainbow.

THUMB PORTRAITS.

EVERY one knows how the features change with lapse of years. It is common for a child to be like one parent at one age and like the other at a subsequent period, and often the child would never be recognised in the adult man or woman. The skin wrinkles, the hair darkens often from light whity-brown to rich dark brown ; but the features of the thumb remain the same, and can be identified as belonging to the same individual at any age.

If the "ball," or cushion-like surface of the top joint of the thumb be examined, it can be seen that in the centre—as, indeed, in the fingers also—is a kind of spiral formed by fine grooves in the skin. The spiral is, however, rarely, if ever, quite perfect—there are irregularities, or places where lines run into each other here and there. Examining both thumbs, it will be seen that they do not exactly match ; but the figure on each thumb is the same through life. If the thumbs of any two persons are compared, it will further be found that no two are alike. There may be, and generally is, a "family resemblance" between members of the same family, as in other features ; there are also national characteristics; but the individuals differ.

All this is better and easier seen by taking "proof impressions" of the thumb. This is easily done by pressing it on a slab covered with a film of printers'

THUMB IMPRESSIONS.

ink, and then pressing it on a piece of white paper ; or a little aniline dye, Indian ink—almost anything, may be used. The result will be such an impression as shown in the illustration, which is engraved from actual impressions taken in this way from the thumbs of two men. In the two impressions the characteristic differences can be readily seen.

The Chinese take advantage of all this to identify their important criminals, at least in some parts of the empire. We photograph their faces ; they take impressions from their thumbs. These are stored away, and if the delinquent should ever again fall into the hands of the police, another impression at once affords the means of comparison. The Chinese say that, considering the alteration made in the countenance by hair and beard, and the power many men have of distorting or altering the actual features, &c., their method affords even more certain and easy means of identification than our plan of taking the criminal's portrait. Perhaps we might with advantage take a leaf out of their book.

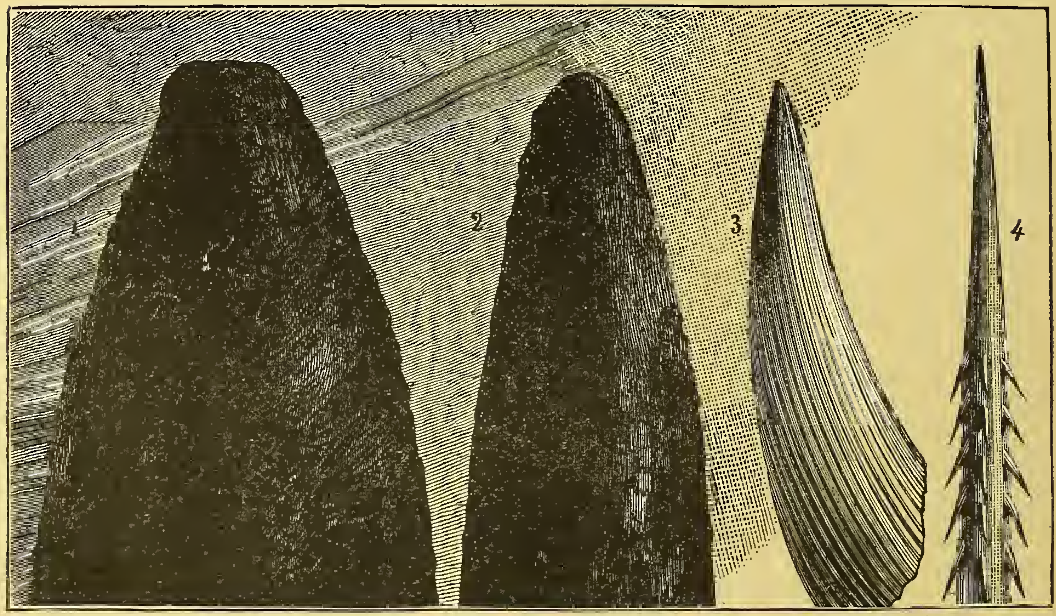
NATURE AND ART.

THE manufacturing arts are now carried to such perfection, that it would seem that there is hardly any task that is impossible to the hand of the skilled mechanic. The giant locomotive which tears its resistless passage along our iron roads, and the delicate little timepiece which lies in our waistcoat-pocket, each tell a tale of the wondrous capabilities of the human mind which designed them, and of the hand which executed them. But even in far more insignificant things we see to what perfection the human hand can attain, and how by means of marvellous machinery articles of every-day use can be produced by thousands with incredible speed and regularity. Common pins and needles may be numbered among these products of the factory. Let us examine one of these needles closely. How smooth it is!—what a brilliant polish it bears!—and to what a fine and delicate point it is drawn! The least pressure on the naked skin with this little dart will show us that its point is sharp, and we no longer regard with wonder its power to penetrate the thick materials it is often called upon to stitch together.

But what does the microscopist say to this beautiful example of manufacturing skill. He will tell us that a fine needle is a very useful thing to him in his work. In preparing an object for the microscope—whether it be of animal or vegetable origin—it often becomes necessary to separate its tissues or fibres (as the case may be), so that its delicate structure may be exposed to view. Needles, set in slender wooden handles, are employed for this purpose, the very finest being selected for the work. So it often happens that the operator, when preparing his objects, has in the field of view under the microscope the objects themselves, and the needles for dissecting them. But what a contrast the latter now present to what they did a minute before. Their size is magnified, it may be 300 or 400 times. The polished steel, in the surface of which the unaided eye could detect no flaw or blemish, is now rugged, and so full of pits and inequalities that it appears more like some weatherbeaten spear-head than the delicate needle which it really is (Fig. 2). A pin shows still more clumsy workmanship when examined by the same critical eye. In addition to its rugged outline, it appears flattened at the point, for the softer metal has been dulled by the constant wear and tear of pinning garments together—although those garments are represented by materials so much more yielding than itself. The coarse appearance of the pin-point — and that one of the sharpest that could be found—is shown in Fig. 1.

Let us now compare these artificial points with some forms of the same kind found in nature. The thorn of a rose is represented at Fig. 3. How much more delicate is the work here shown, when compared with the needle by its side! The rough texture has disappeared, giving place to regular lines which no human hand could describe. In the animal kingdom we can find also innumerable instances of perfection of form in minute processes. Fig. 4 is the image as seen under a microscope of a wasp's sting—the form of which will help us to understand why its wound should be so painful. But the point is as perfect as ever.

Thousands upon thousands of instances might be adduced to prove how wonderful is the world of nature in its minutest belongings. The finest cambric thread which the art of man can produce is as the thickest cable when compared with the weavings of the humble spider. Searching far lower in the scale of life, we come to wondrous forms indeed. The mud from any stagnant pool, the water from a ditch by the roadside, the gravel from the garden-path, examined under the microscope, will introduce us to a world of life of which before we had no conception. When we consider that stupendous chalk deposits and coral reefs, which form continents, are due to the remains of tiny organisms, we must acknowledge that such apparently insignificant creatures may probably be of as much importance as the larger animals which need no microscope to observe them. But however this may be, down to the smallest particles that eye can see, Nature's work is perfect, and suffers nothing under the most minute scrutiny.



ART AND NATURE COMPARED IN THE MICROSCOPE.

FISHES OUT OF WATER.

An old and familiar proverb declares that a fish out of water is one of the most helpless and misplaced of living beings; and in truth, as applied to most fishes, the adage may be said to be justified by zoological science. The beautiful silvery herring, for instance, dies well-nigh as soon as it leaves the sea; and the cod, haddock, and salmon expire, after a few gasps, when they are taken from their native waters and laid on the shore. With certain other fishes, however, the case is different, in degree at least. An eel, for example, is highly tenacious of life. It will survive for a long period after being removed from the water, and its life may be preserved for a very considerable time if the fish is allowed to remain amongst damp seaweed. So, also, some of the blennies are capable of living out of water for long periods of time; but as a rule, a fish expires with even a limited exposure to the atmosphere. Why, then, it may be asked, are fishes incapable of living out of water?

A little reflection shows us that fishes must breathe the same medium as ourselves, namely, the atmospheric air. This consists, as most readers know, of a mixture—not a chemical combination—of two gases, *oxygen* and *nitrogen*. It is the former gas which is the all-important element in the air around us. The animal perishes unless a due supply of oxygen is afforded it. The nitrogen appears to serve as a kind of diluent to the oxygen, since the animal suffers from breathing oxygen in a pure state. The fish, then, breathes the same atmosphere as ourselves, but with this difference: that it breathes the air which is mixed with or entangled in the water, instead of inhaling it directly from the atmosphere, as do land animals. It is a very common error to speak of fishes "breathing water." No animal "breathes water"; it is *air*, and air alone, which is breathed. This air, as we have just noted, is not chemically combined with the water, but is mixed with it. We can, in fact, mix air and water mechanically. If a gold-fish in its globe is perishing from lack of air, we can give fresh air to the water by agitating it with our fingers, or by taking up some of the water in a squirt, and sending the water forcibly into the globe. The water in its descent absorbs fresh air, and in this way we afford the fish a new supply of the aërating medium. In an aquarium a similar principle is carried out for the continued preservation of the tenants of the tanks. We do not require to change the water in an aquarium, as many persons erroneously suppose. What is accomplished by the engine and circulating apparatus of the aquarium is the production of a continuous flow of newly "aired" water. In this way, the water of the tanks remains fresh and pure, and the fishes and other animals obtain the need-

THE CLIMBING PERCH.

ful supply of oxygen from the atmosphere—whence, indeed, the ocean itself obtains its air, through the incessant play of winds and waves.

The breathing-organs of fishes, as every one knows, consist of organs called *gills*. If we lift up the horny flap seen on the neck of any common fish, and known as the *gill-cover*, we see the red gills situated beneath it. The gills in fishes vary in structure. In a common fish, such as the cod or herring, the gills may be described as consisting of a series of beautifully delicate red fringes, resembling the teeth of a comb, and borne upon "arches," which represent the back, or shaft, of the comb. Each of these delicate fringes is in reality a network of blood-vessels, formed by the interlacing of the minute vessels in which the main blood-trunks end and begin. Thus impure blood is pumped into the gills by the heart of the fish, and passes at last into the fine network of which the gills consist. Here it is exposed to the action of the air contained in the water which the fish has "breathed" in. The impure blood is thus rendered pure, and fitted for re-circulation through the body of the animal ; and it accordingly passes out of the gill by blood-vessels formed by the union of the fine vessels of the gill, and is re-distributed to the body. Such is an outline of what takes place in the breathing of fishes ; and the same remarks apply to the breathing-process in man and in all other animals. Whether obtaining air from the atmosphere or from water, the animal demands oxygen, which passes into its blood, whilst at the same time the waste matters of the body and blood are given out. It is these waste matters which render the air around ourselves impure, and which causes the water in which a fish swims to become unfit for the animal's breathing. In the case of humanity, a room or house is accordingly "ventilated," whilst in the case of the fish we similarly renew the air-supply of the water.

This preliminary sketch of what is implied in the ordinary breathing of a fish is a necessary feature for the comprehension of the curiosities which fish-life exhibits in the way of respiration. It is also necessary, however, to note, by way of similar preparation for understanding the peculiarities of the animals involved in the description of fishes out of water, that in many fishes there exists a sac, or bag, known as the "air-bladder," or "swimming-bladder," and sometimes also as the "sound." This latter organ is a bag, containing common air, or gas of some kind, and which in its simplest guise presents the appearance of a closed sac. Its use is that of enabling the fish to rise or to sink in the water. By compressing the gas contained in its swimming-bladder, the body of the fish is rendered relatively heavier than an equal bulk of the surrounding water, and the animal sinks ; whilst conversely, by allowing the air-bladder to expand, the body becomes specifically lighter, and the animal rises in the water accordingly. In some fishes (*e.g.*, herring, &c.) the air-bladder may open into the throat through a tube or duct, and in others, again, it seems to possess a curious relationship to the organ of hearing. We shall see presently that this air-bladder, in a very important fashion, enables certain fishes, through its modifications, to live out of water, and practically to become denizens of the land.

Very varied contrivances are known to exist in fishes for the purpose of enabling them to exist independently of a continued residence in their native element. One of the most notable of these contrivances is seen in a curious fish, known as the Climbing Perch (*Anabas scandens*), found in Eastern Asia. In 1797 Daldorf related that in 1791 he had captured one of these fishes "in the act of ascending a palm-tree which grew near a pond." It had climbed, by means of its tail and spiny fins, to a height of five feet above the water. In the Malayan language, the fish is known as the "Tree-climber" ; its average length is seven inches. But we are less concerned with the climbing habits of the fish than with the adaptation of its breathing-organs for such an aërial existence. When the head of the climbing perch is examined, we discover that it possesses a very peculiar arrangement of thin bony plates, so arranged as to form a highly-intricate kind of labyrinth. It would appear that this peculiar twisting of certain of the skull-bones increases in complexity with the age of the fish. This labyrinth, moreover, is lodged within a cavity situated near the gills, and its obvious function is said to be that of retaining a supply of *moisture*, which serves in place of the water in which the fish lives, and supplies the condition necessary for the breathing-process when the climbing perch has left the water, and is making its way overland. A somewhat similar adaptation to a land-life occurs in the land-crabs of the West Indies. The gills are kept in a moist state, and these animals are thus enabled to take their long journeys overland. Other naturalists are, however, inclined to believe that the labyrinth-like bones in the skull of *Anabas* really act as a kind of true air-breathing organ, and that they discharge the functions of a true lung. If this latter view be correct, then there can be no need for any moisture to be contained within the bony mazes, since the blood of the fish will be purified by the air which it inhales directly from the atmosphere.

In a nearly-related group of fishes, another contrivance appears to enable its possessors to emulate the ways of land livers. The fishes in question are called *Ophiocephali*. They are fresh-water fishes, found in India and Eastern Asia generally. It was long known that they were able to survive long periods of drought, and that they could live half-baked amongst the mud which was left at the bottom of pools nearly obliterated by the sun. Recent researches show, however, that these fishes are habitually air-breathers—that is, they are accustomed to rise to the surface to breathe air directly from the atmosphere, and this, although they possess the gills of other fishes. Thus we discover these fishes to possess two sacs, or bags, which may be described as offshoots from the throat. If the fishes are kept below water (as by a net tied below the surface of the water in the globe in which they are confined), they make frantic efforts to approach the surface. If prevented from inhaling the atmospheric air, they will die suffocated, as truly as we should apply that term to a dog which had been drowned by being placed in a similar position to the fishes. Here modification has so far affected the lives of these fishes, that they are actually unable to live if not allowed periodically to escape from the water to inhale air. They are much in the position of those animals—near relations of the frogs, in fact, such as the *Proteus* and *Siren*—which breathe by both gills and lungs throughout the whole of life.

More startling still are the facts now known respecting the breathing of certain other fishes of South American waters, named *Sudis* and *Erythinus*. Here the air-bladder becomes converted into a veritable lung, as in two other fishes well known as the *Lepidosiren*, or Mud-fish, of the Gambia and Amazon, and the *Barramunda*, or *Ceratodus*, of Australia. These fishes breathe air into the air-bladder, which, instead of aiding them to rise and sink in the water, thus purifies their blood. This curious fact explains how such fishes are able to survive the droughts and dry seasons of their native lands. So long as they exist in the water, they breathe chiefly by their gills; but when occasion requires—if, indeed, they do not habitually respire atmospheric air as well—they convert themselves into lung-breathers, through the air-bladder serving the function and taking the place of the lungs of higher animals.

Another fish—*Hypostomus* by name—rises to the surface to breathe with great regularity. It is necessary to remark that in this fish it is not the air-bladder which becomes the air-breathing organ, but a pouch given off from the digestive tube, just behind the stomach. Such a fact, taken in connection with the modifications already noted, shows clearly that Nature may, and does, attain a special object in a great variety of ways. In one fish it is the head which is modified for air-breathing, in another it is the air-bladder, in a third the throat, and in a fourth the stomach. Still more curious is it to find that in another fish the air for breathing is taken in and expelled through the intestine, or posterior part of its digestive system. This fish (*Callichthys*) also ascends regularly to the surface in order to breathe. It can live completely out of water, and it can also exist in water from which the air has been expelled by boiling, and on the surface of which a layer of oil prevents the access of air. But if prevented from gaining access to the outer air whilst thus situated, it dies. In this case, the gills are evidently inadequate to discharge the functions they originally possessed in the fish under consideration, and which they still possess in other and ordinary fishes.

Doras, a South American fish, which breathes like a species already described, by means of an offshoot of its digestive system, is known to travel overland in quest of fresh waters, when its pools have been dried up by the sun's heat. Dr. Günther tells us that "these journeys are occasionally of such a length that the fish spends whole nights on the way, and the bands of scaly travellers are so large, that the Indians who happen to meet them fill many baskets with the prey thus placed in their hands. The Indians supposed that the fish carry a supply of water with them, but they have no special organs, and can only do so by closing the gill-openings, or by retaining a little water between the plates of their bodies, as Hancock supposes." As we have seen, however, the Doras possesses in its digestive system a special means for aërating the blood in its overland journeys.

The examples thus detailed of the wonderful means whereby Nature modifies the habits and structure of the children of life need no comment. If any moral need be drawn from these curious histories it is simply this: that the whole universe of life is continually being subjected to change and alteration, and that new ways of life and new forms of life are perpetually being evolved from the old ways and from existent organisms. The adaptation of the fishes of to-day for a land existence may, in fact, repeat the history of ancient fishes, whose descendants we see in the frogs of to-day, which begin life as fishes, and end it as land-living animals.

ELECTRICAL INDUCTION.

One of the most notable discoveries of the great Faraday was the fact that an electric current passing through a wire will *induce* another current in a wire near it. To more fully understand this action we must refer to a simple experiment that can easily be made with the help of a battery cell and a galvanometer. The galvanometer must have its two terminals bridged over with a piece of copper wire. The battery being placed near it is also furnished with a similar loop of wire, which can be conveniently brought near to the loop which covers the galvanometer. The battery loop should, in the first instance, be connected only by one end, but directly the circuit is closed, by joining the free end of the wire to the other pole of the battery, the galvanometer needle will be deflected, but will immediately resume its normal position. On again breaking the circuit by once more detaching the wire, the needle again moves, but in the opposite direction, once more immediately resuming its old position. We learn from this experiment that a current can be induced in a neighbouring wire, and that that current is but of a transient character, manifesting itself only when the exciting or primary current is made or broken.

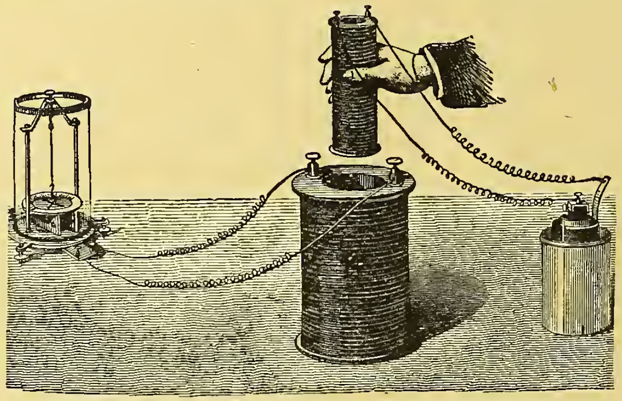


Fig. 1.—INDUCED CURRENT.

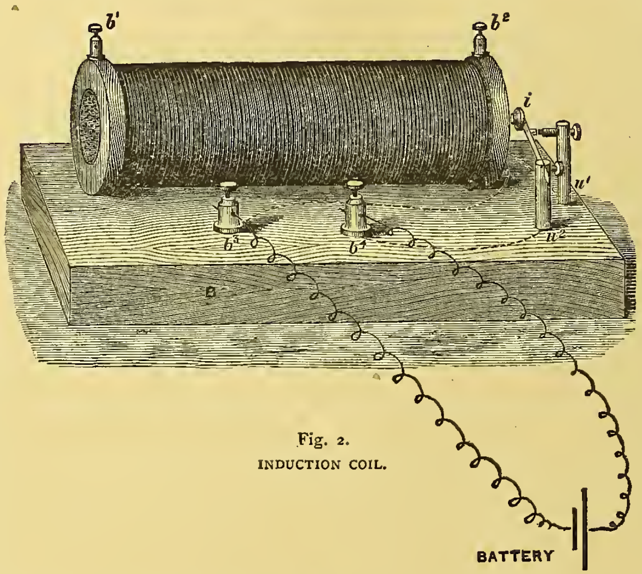


Fig. 2.
INDUCTION COIL.

This experiment can be varied by using helices or coils of wire instead of mere loops (see Fig. 1). The coil to which the galvanometer is attached may be hollow, so as to receive within it the smaller coil in connection with a battery. When the smaller coil through which the current is flowing is placed within the other, the galvanometer needle is deflected, and when the coil is withdrawn the needle once more moves, but in the opposite direction. In both cases the needle quickly returns to its normal position. We thus see that an induced current differs from an ordinary battery current in not being continuous. But an approach to continuity may be obtained by causing the makes and breaks of the circuit to follow one another in quick succession. We can bring about this result by interposing in the battery circuit a common file. Then by drawing the wire from the other pole of the battery along the rough surface, the current will be quickly closed and ruptured as the pointed wire crosses the ridges of the file. With such an arrangement the needle of the galvanometer will be seen to rapidly oscillate from side to side.

These induced currents, but of a very exalted character, are now obtained by means of an instrument called the inductorium, or induction coil (Fig. 2). This apparatus, which is capable of giving some of the most remarkable and beautiful effects that can be obtained, is merely a modification of that experiment just described in which a coil through which a current is passing is placed within another coil, so as to induce a current in the latter. In the inductorium we have two such coils, one being permanently fixed within the other. The inner coil is made of stout copper wire, covered with cotton, which is wound upon a kind of reel, or cylinder of cardboard, with ebonite ends. This thick wire constitutes what is known as the *primary* coil, which is ultimately to be put in connection with a battery. The primary coil is continuous, and is carefully wound on the reel from one end to the other, and back again, so that the terminals (b^3 and b^4) are brought together ready for attachment to the battery employed.

The secondary coil is made of much finer wire, which is insulated, or covered with silk. It is separated from the primary coil by some non-conducting substance, such as india-rubber tissue, varnished or paraffin paper, and as it is wound above the primary coil the greatest care is exercised in insulating one layer of wire from its neighbour. The modern practice is to wind the secondary coil into sections, and in order that the various layers of wire in each may be well insulated from one another, each section is placed for a time in hot melted paraffin wax. This material soon saturates the coil, and when it becomes cold it is so hard and compact that the instrument is which is almost identical with the armature of a common electric bell of the "trembler" form. It consists of a piece of flexible metal (*i*) with an iron head. This is placed so as to face the centre of one end of the coil, and is caused to vibrate in the following manner.

The coil has a core consisting of a bundle of iron wires cut to the same length. The ends of these wires, which are flush with the sides of the

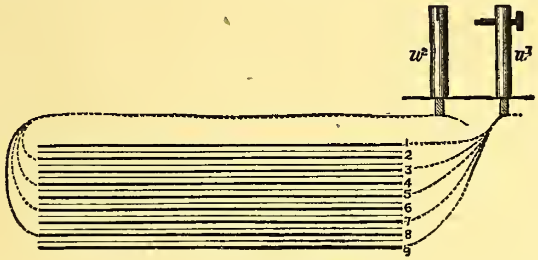


Fig. 3.—CONDENSER.

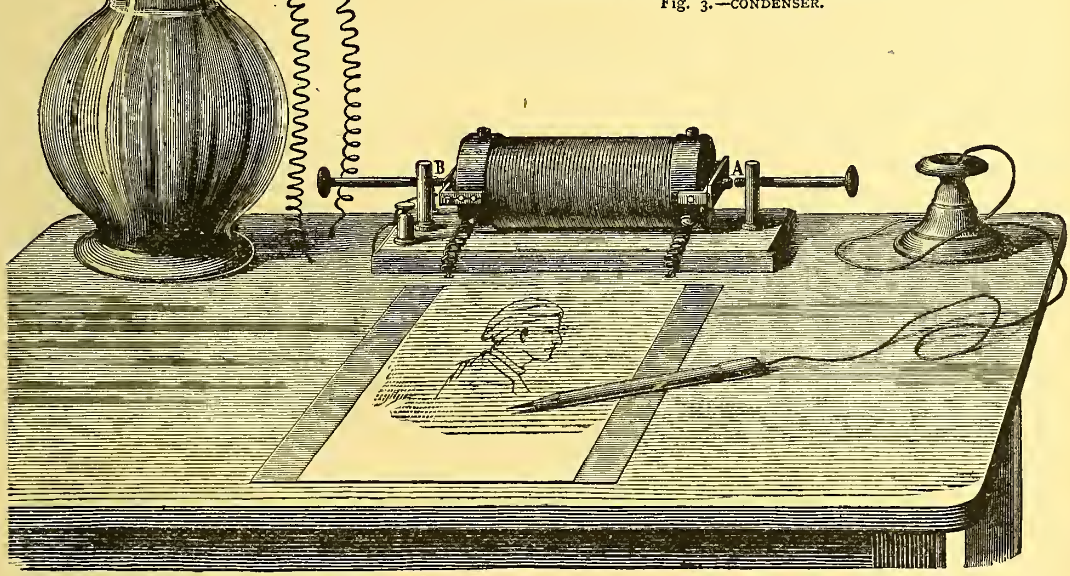


Fig. 4.—EDISON'S ELECTRIC PEN.

not only well insulated, but is protected by the same means.

It will now be understood that an inductorium consists of two coils, one within the other; the inner, or primary coil, being connected with the battery, and the secondary, or outer coil, terminating in two connecting screws (b^1 and b^2), to which wires for experiment can be easily attached. But there is one thing to be provided without which such an instrument would be of no use, and that is a contact-breaker, by which the battery-circuit can be quickly made and broken. There are many contrivances for accomplishing this end, but the most common form is the vibrating contact-breaker, reel on which the coil is wound, constitute the poles of a powerful magnet whenever the battery-current flows through the primary. Therefore the contact-breaker is attracted towards the core. But in the act of moving it is caused to break the battery-circuit, the magnetism ceases, and the flexible metal flies back to its old position. In this way it is kept vibrating backwards and forwards, breaking and making the current several times in every second, the number of its vibrations in any given time depending upon its length and thickness.

The character of the spark obtained from the secondary or induced current is very different from the feeble spark which the wires from a battery-cell will exhibit when brought together. In the latter case no spark is apparent until the two terminals actually touch. Indeed, in using a powerful battery of fifty or sixty cells, the thickness of a piece of tissue paper is sufficient to prevent a spark from passing. But the induced current behaves more like the current from a frictional machine. It will give a noisy discharge, and will leap over wide distances. In fact, induction-coils are often classified by the distance so covered, or, as it is commonly described, by the "length of spark." Even a tiny coil giving a quarter-inch spark will administer a shock which will not be forgotten, and the shock from a coil of moderate size is of a severe and dangerous character.

The discharge from a coil becomes far more violent if the primary coil is connected with a condenser, consisting of a number of sheets of tin foil insulated from one another (Fig. 3). In modern coils such a condenser is usually placed out of sight in the box or base upon which the coil is mounted (B, Fig. 2).

In Fig. 3 will be noticed the way in which the leaves of tin foil are laid one on another, but each separated by a sheet of paraffined paper or other non-conducting material. The figures 1, 2, 3, &c., show how alternate leaves are connected together — the odd numbers on one side and the even numbers on the other side. The way in which this condenser is connected with the induction-coil is indicated by the letters u^1 and u^2, which correspond in Figs. 2 and 3.

Having thus briefly described the Induction-Coil, we will now refer to some of the phenomena which can be exhibited by its help. At one time it was much used for firing mines in combination with Statham's fuse, but now a magnetic machine has supplanted it. But the coil is still used for lighting gas-burners in large buildings. The disruptive action of the spark can be illustrated by laying a sheet of tin foil upon a table or other support, and connecting one of the terminals with it. Upon this tin foil is laid a piece of writing-paper, and it will be found that whenever a wire from the other terminal of the coil is brought above it, the spark in passing will puncture a hole. In this way, and with a suitable pencil, which might consist of an ebonite tube with a metallic core, any pattern or writing can be traced. This plan was lately advanced as one by which manuscripts and drawings could be readily multiplied; the original being transformed into a stencil of this kind, and then brushed over with some kind of ink which would sink through the perforations, and so impress the design on any sheet of paper placed below it. Fig. 4 shows the instrument and mode of action, as adopted in Edison's Electric Pen. Wires from the single-cell bichromate battery are connected up with the induction-coil B A, while one of the wires from the secondary or intensity coil leads to the metal core of the pencil, and the other comes underneath the table to the tin foil on which the sheet of paper is laid. The pencil has only to be drawn over the outline quickly, as the contact-breaker will prevent the perforations from being continuous.

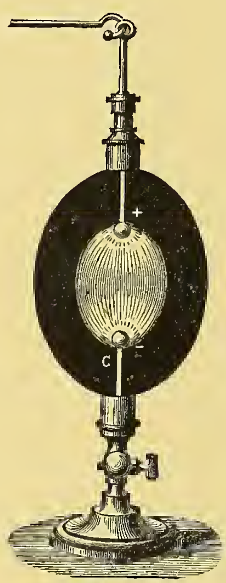


Fig. 5.
DISCHARGE IN VACUO.

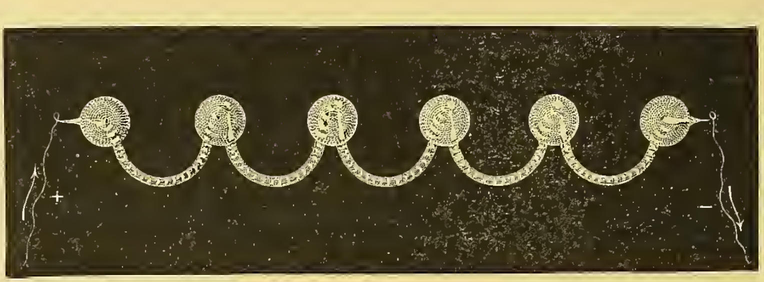


Fig. 6.—GEISSLER VACUUM-TUBES.

Many other curious effects can be obtained from an induction-coil. A piece of fine iron wire placed between the electrodes will become red-hot. Leaf metal is rapidly deflagrated if placed in the same position. Gun-cotton, ether, phosphorus, and other inflammable bodies are readily ignited by the passage of the spark. A Leyden jar can be charged if one electrode be fastened to its ball and the other be held at a little distance from the outside coating of tin foil. Indeed, the number of experiments that can be performed to show the action of the induced current upon different solid and liquid bodies are innumerable, and are highly important scientifically; but for splendour of effect they are altogether surpassed by the behaviour of the current when passed through rarefied atmosphreres.

A simple instrument for this purpose is shown at Fig. 5—a glass globe with a stop-cock attached so that it can be placed on an air-pump, and exhausted of air until it contains but a very attenuated atmosphere. The two electrodes are carried through the ends of the globe, and directly the attached coil is put into action the current passes between them ; but not as a succession of detonating discharges, but as a beautiful glow of light, the terminals themselves being surrounded by a peculiar radiance. If the globe be still further exhausted, and the vapour of some hydro-carbon such as naphtha be introduced, the light will be found to undergo a great change. The globe will now be filled with curious zones or belts of light which appear to keep up a continual rotation. A metallic conductor held to the side of the glass will cause the current to be diverted to that side, and will produce a very curious effect. We need hardly point out that all these experiments must be made in a dark room, for the luminosity is not of a sufficiently brilliant character to be otherwise well seen.

Glass tubes for showing these phenomena were first constructed by Geissler, of Bonn, and are hence known as Geisler's tubes, or vacuum-tubes. They are now also extensively made in this country, and generally in a highly ornamental form (Fig. 6). Such tubes can also be made into letters and words, which become luminous directly they are connected with a coil. Of late years many improvements have been made in these tubes, by introducing within them not only different vapours, but liquids which possess the property of fluorescence. A solution of sulphate of quinine, for instance, although quite white by ordinary light, becomes a rich blue when viewed by the light of a vacuum-tube. Glass which has oxide of uranium in its composition is also subject to a strange change of colour, appearing yellow by ordinary light and bright green by the light from the induction-coil. Sulphide of calcium and sulphide of strontium are also used in the construction of these tubes, because of their phosphorescent qualities. Tubes are now made combining these different materials, and giving a very splendid effect.

It will be remembered that the discharge is not continuous, but is continually being interrupted by the contact-breaker. But the discharges follow one another so quickly that really they appear to be quite continuous, particularly in the case of these tubes, which give out such a wondrous glow. But we can detect the breaks in the current even by sight, and in a very curious manner. By gazing at one of these illuminated tubes, and then moving the head from side to side, successive images of the different discharges will be imprinted upon the retina of the eye. As the image of any object which we see remains upon the retina for at least the eighth part of a second, and as these discharges are far more rapid than that, we see several of these images at the same time, apparently side by side like the rungs of a ladder.

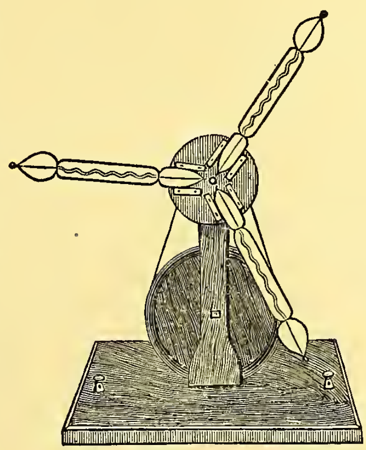


Fig. 7.—GASSIOT STAR.

This curious phenomenon is taken advantage of in the construction of what is called the Gassiot star. One or more vacuum-tubes, in this case, are fixed upon a disc which is caused rapidly to revolve. (Fig. 7). By reason of the apparent multiplication of images on the retina, caused by the rapid movement of the tubes, we see what appears to be a luminous wheel with many spokes. It does not appear to be revolving, although it owes its effect to that cause. Were the electric discharges continuous, there would be an unbroken whirl of light ; but being intermittent, each discharge finds the rapidly-moving tube in a different position, where it shines as a spoke in the wheel. A beautiful variation of the experiment is to select the three tubes all different, or to vary their positions on the disc, and to interpose in the circuit a Reiss transmitter, or other telephone (to be described in a future article). Then on singing into this, the intervals of making or breaking contact are varied, and so every change in the voice makes a change in the pattern of the star.

Several of the experiments to which we have briefly referred can be made with coils and tubes of small dimensions, and such as can be bought for a few shillings ; but where really brilliant effects are required, far larger coils must be employed. One of the largest ever made, if not the largest, is that recently employed by Mr. Spottiswoode at the Royal Institution. This immense inductorium has two primary coils, either of which can be removed by two men and the other placed in position in a few minutes. One is made of wire of a different gauge from the other, and is used for certain experiments to which we need not more particularly refer.

The copper wire for the other primary, which is more generally used, is 660 yards in length, and the secondary coil contains the enormous length of 280 miles of wire. This giant coil will give a spark forty-two inches in length, the contact-breaker working with such rapidity that it will give 2,500 breaks per second. Particulars of the remarkable results which were obtained by this apparatus are noted in the "Proceedings of the Royal Society."

Another large inductorium was made by the same maker some years ago for the Polytechnic, and was recently sold to the South Kensington Museum. The construction of this machine entailed a cost of several hundred pounds, which its proprietors hoped to win back with heavy interest by its exhibition to the public. But in this they were disappointed, for the public were rather alarmed at its thundering detonations; nor were they reassured when they were told by the lecturer that if his hand touched a certain knob the result would be immediately fatal. We may mention that Dr. Richardson conducted some experiments with this coil, in order to note its physiological effects. Sheep and other animals immediately dropped dead when the current was passed through them, but some other animals showed a strange immunity from harm. It has been proposed more than once to slaughter animals in this manner, but for several reasons it would be impracticable.

FLESH-FEEDING PLANTS.

THE remarkable structure of Dionæa, or Venus' Fly-trap, is now very generally known; but is not dealt with at length here, being the subject of a separate article. From numerous recent observations and experiments, much of the obscurity that enshrouded the meaning of such remarkable organs has been cleared away, and we now know that such structures are nothing less than adaptive contrivances developed by flesh-feeding plants for

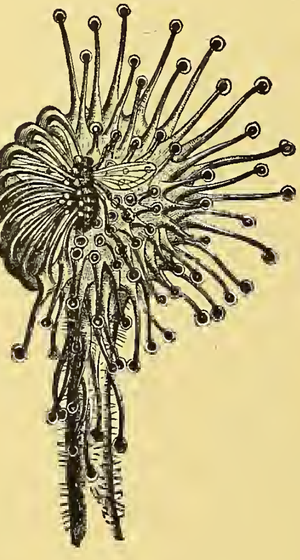


Fig. 1.
LEAF OF SUNDEW.

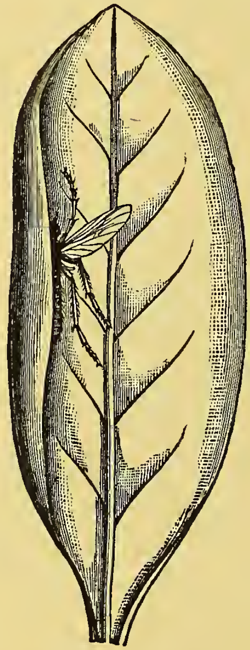


Fig. 2.
LEAF OF BUTTERWORT.

Fig. 3.
BLADDER OF BLADDERWORT.

the purpose of securing for themselves a supply of animal food.

Lengthened and unremitting research has discovered the existence of carnivorous habits in many plants. In England, the little sundew plants, butterwort, and bladderwort; in America, the trumpet, or side-saddle-flower; and in the Old World, the true Australian pitcher-plants, are all good examples of vegetable insectivora.

The sundew, or Drosera, is a very small plant, found in spongy bogs, the almost round leaves being spread about on all sides over the damp moss. The leaves are closely beset with hairs, or tentacles, each ending in a viscid or sticky knob-like gland. Upon examination, each leaf will most probably be found to retain one or more captive insects, mostly flies, or else the dead or mangled bodies of late captives. The flies are caught by each alighting on the sticky substance that covers what will presently be shown to be the very sensitive tissue of the gland; its struggles to escape induce on all sides a remarkable movement of the tentacles, which sooner or later surround the vibrating object, while the excited glands pour out a secretion, in which the body of the doomed insect is slowly digested (Fig. 1).

Looking a little more closely, it may be observed that the closely-set tentacles vary considerably in length and direction, according to their position, those in the centre being very short and upright, while those towards and around the circumference are comparatively long, and either in the same plane as the leaf, or else reflexed. The average number of tentacles on each leaf has been computed to vary from 130 to 260, or thereabouts. When a fly alights upon the leaf, it is retained, as we have seen, by one or more of the sticky glands. A motor impulse is immediately propagated to neighbouring tentacles, causing them to move and inflect in such a way as to approach, and subsequently clasp, the struggling prey. And further, immediately the tentacles commence moving, the glands become locally active, and are excited to secrete the viscid fluid with greater freedom. What is more remarkable still, the fluid thus secreted, even from the first movement of the tentacles, differs in a notable respect from the normal fluid in being distinctly acid—an important property, which certainly endows it with a solvent power unpossessed by the neutral fluid.

Fig. 4.—SARRACENIA.

The length of time taken by the tentacles to complete their movements varies from one to five hours, depending upon the vigour and age of the leaf, size and nature of the object—that is, whether or not it contains soluble substances of the proper kind—and finally, upon the temperature: conditions upon which the duration of the inflection of the tentacles—varying from one to seven days—also depends. Minute flies were found to be well embraced by the tentacles in a few hours, while tiny balls of paper, bits of moss, quill, and such like non-nutritious bodies, were either not embraced at all, or only a very few, and that not until after the lapse of twenty-five hours. Yet, when the balls of paper or bits of moss were removed, and replaced by morsels of raw meat, the tentacles were immediately inflected. Again, minute pieces of meat were placed by means of needles on some of the marginal glands, when the tentacles were greatly inflected, and carried the objects in five or six minutes to the centre of the leaf; at another time, pieces of flies were carried to the centre in thirty-five minutes through a distance of 180 degrees; while in yet other cases, minute flies were carried to the centre of the disc in one hour and thirty seconds. But even more remarkable were the experiments showing how particles of extreme minuteness were sufficient to cause inflection of the tentacles. Bits of blotting-paper weighing $\frac{1}{465}$th of a grain, and bits of cotton thread $\frac{1}{50}$th of an inch in length, and weighing only the $\frac{1}{8797}$th of a grain, were found to cause inflection; in the latter case, the gland carried the bit of thread to the centre of the leaf in one hour and forty minutes; while further, a minute morsel of human hair, the $\frac{8}{1000}$th of an inch in length, and weighing so inconceivably little as the $\frac{1}{78740}$th of a grain, induced a distinct movement of the tentacles. Mr. Darwin, remarking upon the last and other experiments, conjectures that this piece of hair could hardly have exerted a pressure equal to the millionth of a grain, remarking how "a bit of hair $\frac{1}{50}$th of an inch in length, and therefore much lighter than those used in the above experiments, was not perceived when placed on my tongue, and it is extremely doubtful whether any nerve in the human body, even if in an inflamed condition, would be in any way affected by such a particle supported in a dense fluid, and slowly brought in contact with the nerve. Yet the cells of the gland of Drosera (or sundew) are thus excited, and transmit a motor impulse to a distant point, inducing movement."

But the behaviour of the leaves when placed in various kinds of fluids gave perhaps the most extraordinary results of all. In perfectly pure or distilled water no movements were observed, nor could any movements of the tentacles be induced by immersing the leaf in solutions of any organic substance not containing nitrogen; while milk, infusions of meat, isinglass, and such like nitrogenous substances, produced inflections on every trial. The plant likewise showed a sensitiveness to inorganic substances containing nitrogen: for instance, when a minute drop of phosphate of ammonia, containing $\frac{1}{153600}$th of a grain, was held for a few seconds in contact with a gland, the tentacle was induced to move; while even still more extraordinary, if a leaf is immersed for a short time in a solution so weak that a gland can absorb only the $\frac{1}{19760000}$th of a grain, it will be enough to excite the tentacles into movement, and cause their complete inflection.

If it is remembered that nitrogenous substances are beyond all comparison the most essential and scarcest constituents of plant-food, the advantage of this amazing sensitiveness to the presence of such substances as raw meat and ammoniacal compounds will be readily recognised.

It is well-known that digestion is brought about in the animal stomach by the action of a ferment called pepsin, in presence of a weak acid. Now, it has been before remarked that immediately an object touches and excites, say the disc-glands on the leaf of Drosera, they at once commence to secrete an acid juice; a motor impulse is propagated to the marginal tentacles, in consequence of which they commence their inflection, at the same time also secreting an acid fluid. If the object caught turns out to be merely a fragment of useless matter, the tentacles relax, and the flow of acid secretion ceases; but should the object, on the other hand, happen to be of a nitrogenous nature, the tentacles will remain closed, and, in addition to the acid fluid, the glands will secrete a digestive ferment analogous to pepsin, which, acting in conjunction with the acid, will as thoroughly digest the animal matter as would the stomach of one of the *Carnivora*.

In the common Butterwort, we have the leaves performing a similar function of digestion and absorption, but the mechanism of the organ is somewhat different from that of the sundew. The plant is an inhabitant of wet bogs and other moist land, but generally, it is said, affecting mountainous districts. Its spreading leaves are of an elongated oval form, and their upper surfaces—except at the margins—are covered with very short glandular hairs, that secrete a colourless viscid fluid, which fulfils, as in Drosera, the double function of catching and digesting insect food. When an insect creeps over the edge, on the upper surface of one of the leaves, it is not long until it is caught fast in the sticky secretion; the margin of the leaf along its whole length, on the side nearest the struggling intruder, then becomes slowly incurved, and in time clasps the insect, thus making its capture secure. It is then digested and absorbed (Fig. 2).

The common Bladderwort, found in many deep pools and water ditches throughout the country, has a most ingenious contrivance for entrapping minute aquatic animals, and using them for purposes of nutrition. Little stalked bladders, until quite recently described as floats, are found at the base of the young leaves, springing from the spreading root-like branches. The bladders are about a quarter of an inch or less in diameter, and provided with a short stalk at one end, and a pair of branched hairs, or "antennæ," at the other (Fig. 3). On the under, or inner, surface of the bladder, and towards the end, there is a broad slit, or opening, to the margin of one side, to which a flap or valve is attached, and having its free end sloping into the cavity of the bladder, and resting on a rim, or collar, springing from the base of the opposite side of the aperture. The contrivance is such, therefore, that the valve admits of ready entrance to the bladder, but effectually prevents egress. As the plant generally delights to live in rather foul water, these bladders collect a vast number of aquatic animals, including insects, small crustaceans, and even worms, all of which are eventually killed, choked or asphyxiated, in fact, in their confined water prison. After this, they gradually putrefy, as in this case the bladder has apparently no digestive power, like the sundew and butterwort. The soluble products of putrefaction are absorbed, thus contributing in no mean way to the general support of the plant.

Passing now from native British plants with carnivorous habits to those found in other parts of the world, we will first describe the trumpet, or side-saddle flowers, or Sarracenias, of North American bogs. The leaves, which are often a foot or two long, spring from the earth, and are developed in a characteristic manner. The blade is incurved, and so formed, that for the greater part of its length its opposite margins are united, thus producing a trumpet-shaped pitcher, the upper free portion of the blade forming a scoop-shaped arching hood (Fig. 4). These vessels are generally half-filled with water, in which numerous ants, flies, and other insects are drowned, forming a rich and nutritive food for the vegetative needs of the plant. But how does it catch its prey? The adaptive contrivance is certainly most ingenious and effective. The inner surface of the upper portion of the tube in the neighbourhood of the entrance is coloured most attractively, and provided with a great number of honey-glands, that keep the surface well lined with nectar. Beneath this, the surface is rather glossy, and clothed with long glossy hairs, that lie so that their ends point downwards. Immediately beneath this there is another region, the surface of which is still more smooth and slippery, while the liquid lies in the lowest region of all, the surface of the walls of which is armed with long stiff hairs, pointing obliquely downwards. Attracted by the showy colouring, an insect may alight on the upper region of the pitcher, and begin at once to sip the honey which is found so abundantly around. Following this "honey-baited pathway" for some distance into the tube, it will soon reach the second region, where, finding no foothold, it will drop, perhaps head downwards, for a short distance, but, soon recovering itself, it will make a vigorous struggle to escape; coming in contact, however, with the opposite wall, it will instinctively endeavour to alight, so as to make a fresh start, but again finding no foothold, it will again slip; and this may take place several times, each effort only sinking it lower and lower in the tube, until at last it is tumbled headlong into the water. Once immersed, there is no escape, for not only is the water of a clammy or sticky consistency, but the deflexed hairs prevent any attempts at climbing up the side wall. In a short time the unfortunate feaster is dead, after which it is soon decomposed and absorbed.

The true pitcher-plants—or Nepenthes of botanists—are inhabitants of the Old World, chiefly affecting the warmer regions of the Malay Archipelago. The pitchers are, as may be readily conceived from analogy, merely modifications of a portion of the leaf, being developed from the part at the point, the basilar portion of the leaf-blade retaining its normal appearance. The two parts are separated by a length of naked midrib, forming, in cases where the plant wishes to secure ground game, a cord of considerable length—just so long, indeed, as to place its pitcher in a convenient position on the ground. The mouth of the pitcher is kept permanently distended by a thickened corrugated ring, which secretes a plentiful supply of honey. This honey is, of course, only the old familiar bait to lure the unwary nectar-feeding insect into the ingenious trap artfully arranged for its capture. A walled pathway, leading in a most direct manner up to this delectable feeding-ground, is even constructed evidently for the express service of all roving insects. This narrow alley is formed by two longitudinal fringed wings, extending from the base of the pitcher to the rim, and is often the means of guiding many an unfortunate insect to certain death. Further, the ring in many species turns over, and dips into the pitcher, ending in a marginal row of stiff spines, forming an insurmountable barrier to all imprisoned climbers. The lid, while keeping out useless objects that might by accident fall into the vessel, forms, from its showy appearance, an attractive object to insects and other small animals. Below the spinose margin of the inflexed rim, the inside surface of the wall of the pitcher is so smooth, that it is absolutely, or almost, impossible to gain a foothold; below this region the walls are glandular and secretive, enclosing the liquid contents of the organ. The number and variety of animals these pitchers entrap are simply wonderful; sometimes even small birds, endeavouring to steal the caught flies, are themselves caught, and ultimately digested. As to the digestive functions of the plant, the glands seem first to secrete an acid juice, then a true digestive ferment, or peptone; and from experiments recently conducted, it would seem that all sorts of nitrogenous organic compounds can be successfully dealt with in this monster vegetable stomach.

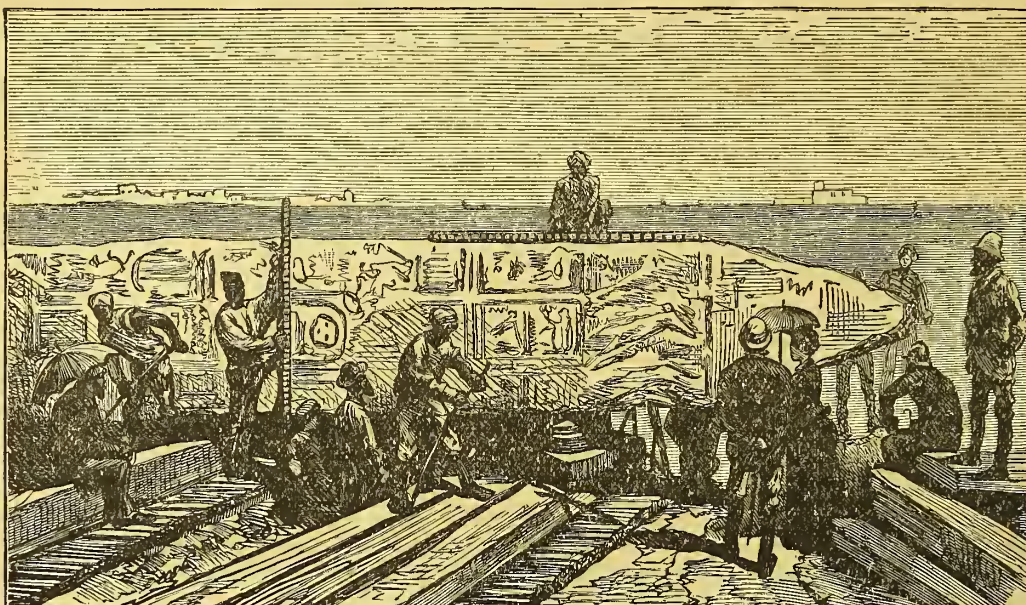
We have now seen that at least in one relation—that of digestion—the great functional barrier once supposed to exist as sharply separating the animal kingdom from the individuals in the world of plants has completely and for ever broken down; for here we have such plants as the sundews in England, the trumpet-flowers of America, and the pitcher-plants of the Old World, with a power rivalling, in its thoroughness and efficiency of action, the digestive operations of any of the higher *Carnivora*. We see also that in another relation—that of sensitiveness—some plants, at all events, are able to instantly respond to outward impressions; and that in one plant we have been considering—the sundew—this sensitiveness actually exceeded the keenest sense of feeling in even the highest-developed of all animals—Man!

CLEOPATRA'S NEEDLE.

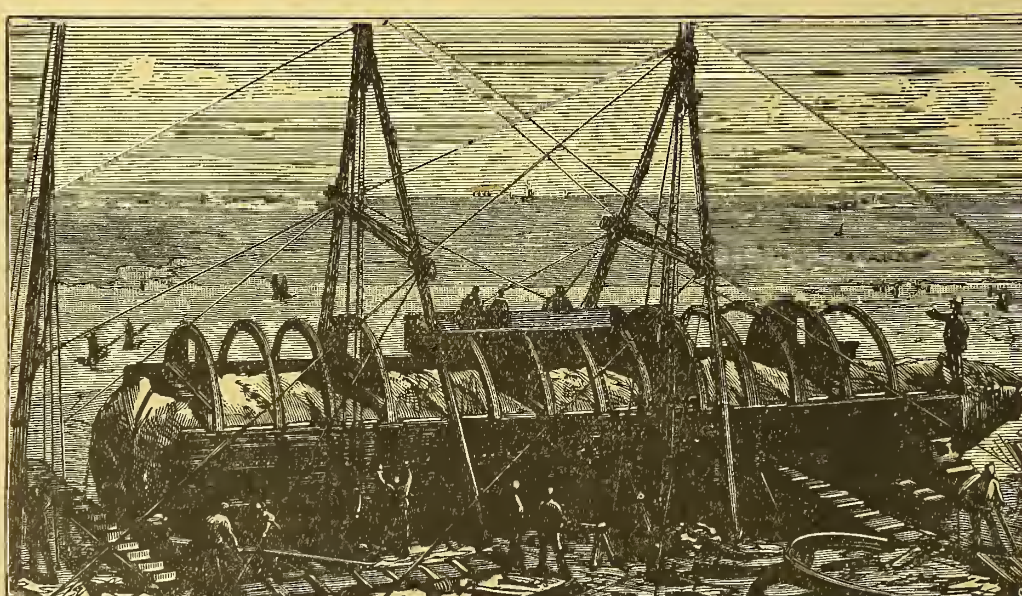
THE ancient Egyptian obelisk which very recently found a resting-place upon the Thames Embankment, between the Charing Cross and Waterloo bridges, is one of several monoliths to which the same name of Cleopatra's Needle is applied. It is, however, a complete misnomer, as these monuments date from a period long before the time of the renowned Egyptian Queen, with whom they have no sort of connection.

The obelisk was, amongst the ancient Egyptians, symbolical of the Supreme Being; and the sun being with them an object of worship, the Egyptian priests styled these monoliths the Fingers of the Sun, while the Arabs called them Pharaoh's Needles, a term quite as inappropriate as our more familiar name. Amongst the few objects of interest in the neighbourhood of Alexandria were these so-called Cleopatra's Needles, and the famous column, now universally but incorrectly called Pompey's Pillar. The needles were situated in the immediate vicinity of the Palace of Cleopatra, which was built upon the walls facing the port of Alexandria, and doubtless from this association they acquired their erroneous appellation, though, as will presently be seen, they were not erected until some years after the death of the last native Egyptian ruler in 30 B.C. A learned Frenchman, named Denon, who accompanied the French army of 1798 into Egypt, supposed these pillars had at one time decorated the entrance to the Palace of the

Ptolemies, the ruins of which are not far distant; but later it was decided that they had been brought to this spot from some ancient Egyptian Temple during Greek or Roman rule, and are stated to have been originally erected at Heliopolis about 1600 B.C., by the King Thothmes III. As, however, amongst the hieroglyphics with which they are covered, the names of Thothmes III., of Rameses II., and of a still later king have been deciphered upon one of them, it seems probable that their true history and origin has yet to be discovered, and all of which we can be assured is



ADJUSTING THE OBELISK PARALLEL TO THE SHORE.



CONSTRUCTION OF THE CYLINDRICAL CASE.

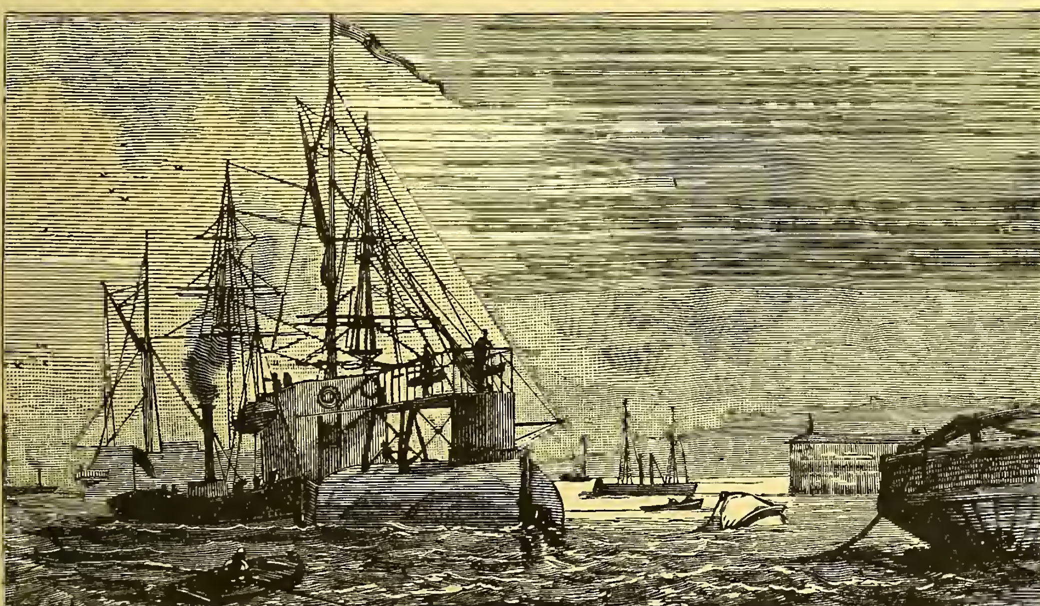
that they date back to an early period of Egyptian history, and form a part of that strange forgotten record of ancient civilisation which has for so many ages puzzled the learned of more recent times.

Regarding the removal of the needles to their site before the ruined palace of Cleopatra, we have, however, at last obtained the most certain knowledge. Mr. Dixon, the able engineer entrusted with the transport of the English obelisk, knowing that these monoliths were frequently supported at their base by feet of metal, obtained the sanction of the Khedive to examine the buried base of the still erect needle, in the hope of discovering some clue to the date of its erection. After the removal of the accumulated sand and *débris*, it was found that the obelisk was supported upon its plinth to a great extent by rude and insecure masonry, but at one corner was seen a bronze crab, on one claw of which, after careful examination, a Greek and a Latin inscription were deciphered, which finally decided the question so long in dispute amongst archæologists. As each of these inscriptions, which were impressed upon the surface of the metal, was to the same effect, we will transcribe only that in Latin :—

ANNO VIII.
AUGUSTI CAESARIS.
BARBARUS PRAEF[ECTUS].
AEGYPTI POSUIT.
ARCHETECTANTE PONTIO.

Thus, as Augustus Cæsar was prefect of Egypt from 29 B.C. (the year following the death of Antony and Cleopatra), until the year 14 A.D., we learn that this, and doubtless the other needles, was erected by the engineer Pontius in 21 A.D., and was placed before the Cæsareum of Alexandria, or, as it is sometimes called, the Temple of Augustus Cæsar.

The English obelisk, like that still left standing in solitary state at Alexandria, is of that hard, compact red granite known as Theban stone which was obtained from the quarries at Syene, on the Nile, and consists, roughly, of 70 per cent of feldspar, 20 per cent. of quartz, and 10 per cent. of mica. As has been already stated, it is covered on every side with hieroglyphics, a description and translation of which have been already published by Dr. Birch, the well-known antiquary of the British Museum. With this, however, we have no concern, but must pass on to consider the skill displayed by the engineer in the removal of this immense block of solid granite from its place in Egypt to its so far final destination on the banks of the English Thames.



ARRIVAL OF THE OBELISK AT GRAVESEND.

The obelisk was first acquired for this country by Sir Ralph Abercromby in 1801, at which time it had been long embedded in the sand and mud of the shore. Not being removed at that time, it was again offered to the English by Mehemet Ali, the first Khedive of Egypt, but was still permitted to remain buried in its sandy bed. On the 15th March, 1877, however, the present Khedive renewed the offer made by his predecessor; and Professor Erasmus Wilson having most liberally undertaken to pay all the expenses of its removal, it was at length resolved to bring it to this country, Mr. John Dixon, the engineer, taking upon himself the immense responsibility of its safe transit.

Of course, many and various schemes were not wanting, when its removal was finally decided upon; and one of the projects discussed by Mr. Dixon and his brother and coadjutor was the cutting of a canal from the sea to the site of the buried obelisk; but this he at length decided to be impracticable. Eventually it appeared to Mr. Dixon and his brother that the simplest method which could be adopted for the removal of the Needle would be to allow it to remain where it lay on the shore, and to construct around it a strong iron cylinder, in which it could be completely enclosed, and of sufficient strength to permit of its being rolled, with the obelisk inside it, from the place of its erection down to the water's edge. In pursuance of this plan excavations were made about the Needle, and the cylinder was gradually built up to enclose it. Having carefully calculated what volume of air would be sufficient to float the weight of the cylinder and the contained monolith, Mr. Dixon constructed his vessel accordingly; and when completed it was about fifteen feet in diameter, and about 116 feet in length, while the Needle measured sixty-eight feet five and a half inches from base to point, and about seven feet seven inches in width at the base, and weighed no less than 186 tons 7 cwt. 1 qr. 11 lb. The cylinder was divided into ten water-tight compartments, so that in the event of accident to one portion of the shell the vessel might still retain sufficient buoyancy to prevent it from going to the bottom on its passage across the ocean.

The labour of rolling this cylinder down to the water was immense, and the engineer found his difficulties not a little increased by the fact that he had only foreign workmen to assist him, to whom it was impossible to convey his orders with promptness and decision. In spite, however, of this difficulty his operations were conducted in a most masterly manner; and though he judged that some slight injury was done to the air-tight compartments during the works, it was not of a serious character, and was unattended by injurious results. One of the dangers to be guarded against during the course of the cylinder from the place of its construction to the sea was the chance of piercing the metal by stones lying on the line of its passage. To prevent this risk all the stones which could be seen were carefully removed, and the vessel was further enveloped in a coating of wood, which covered that part of it which it was judged would press most heavily upon the ground. Notwithstanding these precautions, however, an accident occurred. When the cylinder was within about sixty-five feet from the place where sufficient water was present to float it, and after it had travelled in safety across some 650 feet of sandy shore, an unseen stone pierced it just beyond the extremity of the wooden casing. Though already partly submerged in water, the calm weather fortunately enabled the engineer to repair the damage without much difficulty; but the delay thus caused prevented the presence of the Khedive when the *Cleopatra* was finally floated into deep water. When fairly launched she was towed to the docks at Alexandria, and there fitted with mast, cabin, helm, and sundry other appliances which might render her passage safer and more expeditious. On the 21st September, 1877, she finally left Egypt, accompanied by the *Olga*, and all went well until the Bay of Biscay was reached. There, however, the *Cleopatra* and her convoy encountered bad weather, during which they became separated, and after six lives had been lost in the effort to recover the Needle, the *Olga* finally abandoned her charge, and the *Cleopatra* was left to the tender mercies of the waves. Later, she was found by the English steamer *Fitz-Maurice*, and was by her towed into the harbour of Ferrol, for which service the owners received £2,000 as salvage. On the 16th January, 1878, the *Cleopatra* left Ferrol in charge of the steamer *Anglia*, and without further mishap reached London eleven days later.

Arrived in London, a site on the Thames Embankment was, after considerable differences of opinion, selected for the Needle, and here, with no small engineering skill, it was finally erected on the 12th September, 1878. Within the pedestal was placed a collection of the productions of the nineteenth century, including a "Bradshaw," some newspapers, and articles of clothing, which may perchance, after the present metropolis has been submerged and again raised from beneath the waters, furnish either information or matter of argument to future generations of savants ages after the greatness of London has passed away.

CURIOSITIES OF COURT ETIQUETTE.

EVERYBODY has read, perhaps, and most people incredulously, the story of that royal lady of Spain (she was Charles II.'s wife) who, falling from her horse, caught her foot in the stirrup, and, being unable to extricate herself without assistance, remained in her ignominious and indecent position until the grand equerry, whose duty it was to assist the royal lady on such occasions, could be discovered and brought to the spot, although some forty or fifty of her attendants stood by, none daring to violate the etiquette of the Court by laying hands upon the royal foot. Or rather, we should say, she would have so remained if a bystander had not released her. He received a money reward, but was not allowed to escape punishment for his "crime," being exiled.

Another, but more tragical story of this wonderful kind of etiquette, and one almost as well known, is that of Philip III., who, finding himself uncomfortably hot in the presence of too fierce a fire, requested the Marquis de Pobar to extinguish it. The Marquis dared not obey, because the Duke d'Useda claimed that privilege, and the Duke was absent in Catalonia hunting. The result was that the monarch "endured" what could not be "cured" without a violation of Court etiquette; and erysipelas being thereby caused, he died!

Because it was Court etiquette for no subject to sit or lie down while the king stood or sat, Louis XIII., when he visited Richelieu at Tarascon, had a couch placed beside the sick bed of his Minister, upon which he could repose while the interview lasted. Louis XIV. did the same when he visited the wounded Maréchal de Villars, after Malplaquet. Napoleon the Great's Book of Ceremonial was as exacting as the Court etiquette of the last-named monarch, on which, indeed, it was based.

In 1808 all the copies of the famous Almanac de Gotha were seized directly they were issued, and suppressed, because, as had before been usual, the reigning Sovereigns were printed in alphabetical order, and therefore began with the Anhalt Duchies, and not with the Emperor Napoleon. The book was consequently reprinted, with the great little Corsican's name placed first.

Cyrus beheaded those who, when they had the honour of saluting him, failed in their obedience to Court etiquette in not placing their hands within their sleeves.

When Sully (then called Rosny) came from France to formally compliment King James on his accession to the throne of England, some gentleman of his suite killed an Englishman at a tavern brawl, under circumstances which collected a mob and created a riot. The man who killed the native escaped to the house of the resident French ambassador, from which Sully had him taken, and finding on investigation that his countryman's crime was murder, he gave him up for trial to the Lord Mayor, in whose court he was speedily condemned to death. But the French ambassador, the Marquis de Beaumont-Harlay, obtained for him a free pardon signed by King James, and within five minutes of his execution obtained his freedom. This created an immense amount of anger and indignation at the French Court, as a breach of royal etiquette which grossly insulted the King of France, who alone had the right to pardon a French subject condemned by French authority. He had been condemned by Sully, and, as the French monarch sent him no pardon, it was said he should, as a matter of etiquette, have been hanged.

WONDERS OF SPONGE-LIFE.

TIME was when a sponge was regarded as belonging to the domain of the botanist, and as representing a group of lower plants. It was not wonderful that the sponges should be regarded as plants. They are plant-like in form; they grow in a rooted and fixed condition; and they are, lastly, destitute of all the visible and apparent signs by which we are accustomed to detect and recognise animal life. But the deeper investigation of the sponge tribe afforded a rich harvest of curious facts to the naturalist. It was discovered, firstly, that in all their essential features sponges were not plants, but true animals. Next, the history of their development was studied, and the facts therein disclosed were found to bear out the idea of the animal nature of the sponge in the fullest possible manner. As time progressed, new facts concerning sponge-history were brought to light, and the class has now taken a stable place in zoological systems as a low, but, at the same time, very distinct group of the animal kingdom.

To enable us perfectly to comprehend the wonders which lie hidden within the compass of a sponge, we must, firstly, endeavour to understand the relationships and nature of the substance used in our households, and familiarly called "sponge." This consists of a horny matter, known to the scientist as *keratode.* It is made and manufactured by the *living parts* of the sponge; just, indeed, as a shell is made by the snail or oyster that inhabits it; so that, in this first plain observation, we light upon a wonder of sponge-life. The secret of the manufacture of the sponge is still hidden from us. We do not know *how* the living matter elaborates, forms, and builds up the horny skeleton we use in our homes. All that we do know is really limited to the observation that the manufacture of this skeleton is characteristic of sponge-life, as much as to make bones is a feature of our own existence.

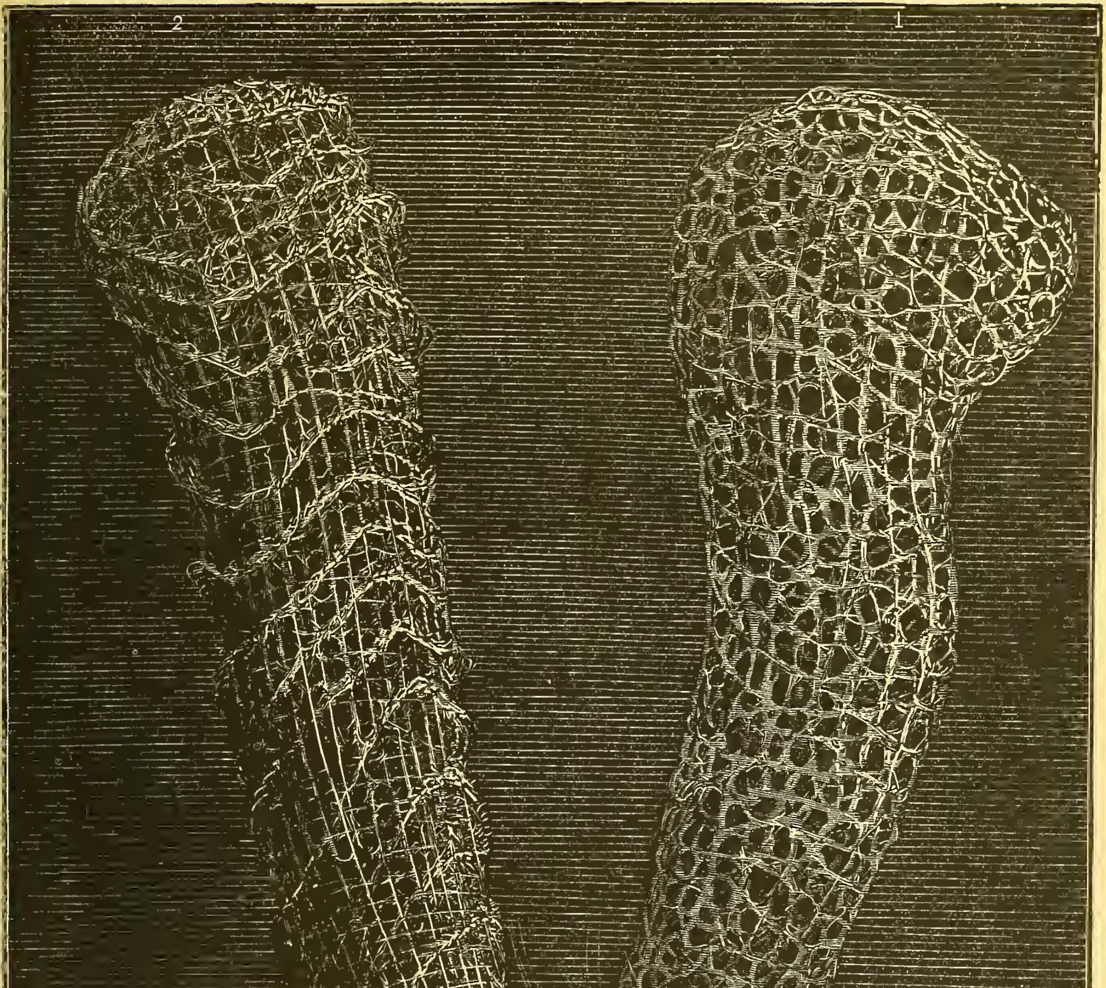
But it is very important that we should not start upon our journey in search of the wonders of sponge-life without bearing in mind that the horny sponges form only one group of their class. Imbedded amongst the horny fibres of the sponge we find needle-like bodies, formed of mineral matter—usually flint—which serve to strengthen the horny skeleton. There are a few sponges known, to which, in all probability, the popular observer would deny the name of "Sponge" altogether. We know of true sponges which thus possess no skeleton at all, and which present the appearance of masses of living jelly—or *protoplasm*—perforated by the canals and tubes so well seen in a common sponge, but showing no traces of firmer parts. We have just seen that in the commoner types of horny sponges the skeleton is strengthened by flinty particles. In another prominent group of sponges, the skeleton is wholly of limy nature, and does not include any horny matter whatever in its composition. It seems strange, with our conventional ideas of a sponge, to apply that name to a mass of limy matter; but these calcareous sponges are amongst the best known of the sponge-class. The limy framework—which in these sponges is, of course, made by the living parts of the animal—consists of beautiful mineral particles, which, under the microscope, exhibit varied and characteristic shapes. Thus, there are many three-rayed *spicules*—as the limy particles are named, but few four-rayed ones; whilst others exist in the form of needles or rods of limy matter. Fig. 1 shows a calcareous sponge.

Naturalists have recognised another group of sponges in the shape of those which have skeletons of *flint*. The common horny sponges, as we have seen, possess flinty particles imbedded amongst the horny fibres, and we can thus readily see that the "flint" sponges are closely related to the horny ones. If we imagine the horny skeleton to become rudimentary, or to disappear altogether, and to give place to the flinty element, which would thus come to the front, we may readily conceive how the flint sponges are really connected with the horny types by close ties of relationship. Amongst the "flinty" sponges we find several forms which, for elegance of outline, and for their innate beauty of form, outrival many other groups of much higher animals. A glance at the full-page illustration will show two of these elegant forms. That on the left is the beautiful "Venus' Flower-Basket Sponge"—or *Euplectella*—a sponge found in the Philippine Islands. This elegant organism well merits its somewhat poetic name. It is composed of an intricate series of flinty particles, woven together so as to present us with a network arrangement of great complexity. The separate particles which compose this skeleton are six-rayed or pointed, and the meshes of the net formed by their union are of many-sided shape. When the "Venus' Flower-Basket" is young, the whole skeleton is flexible; but, as time passes, the flinty elements predominate, and the skeleton becomes rigid and brittle. Above, the "basket" ends in an aperture, which is covered by a network-like lid; and below we see the wisp of flinty fibres, depending like a beard from the sponge, and by means of which the sponge anchors itself in the mud of the sea.

Fig. 1.—COLONY OF CALCAREOUS SPONGES.
(*Ascandra pinus*).

We shall presently endeavour to note the characters of the living parts to which we owe the manufacture of this strange and elegant frame. But, viewing the "Venus' Flower-Basket" merely as a dead and formed piece of life's handiwork, we may justly rank its manufacture among the wonders of sponge-life. Side by side in the illustration with the "Venus' Flower-Basket" is another sponge—*Alcyoncellum*—of nearly related nature, but which hardly equals the former organism in the elegance of its form.

"Sponge" is thus seen to vary in nature, and to present us with horny, limy, and flinty guises. The living matter of a sponge, however, is alone that in which the *personality* of the sponge, so to speak, resides. This living matter consists of *protoplasm*—a jelly-like substance—which, under one form or another, is found wherever life exists. We may easily enough see this living matter if we take a sponge from its native waters. In the common green freshwater sponge—*Spongilla*—which grows in the locks of canals, and is found in our rivers, the living matter is readily seen as a glairy substance, resembling white of egg in appearance. This is the living *protoplasm* of the sponge, which manufactures the skeleton, and which carries on all the functions which characterise and distinguish sponge-life. It covers the external surface of the sponge, and lines the canals that everywhere riddle the sponge skeleton. When the microscope is brought



SKELETONS OF SILICIOUS OR FLINTY SPONGES (NATURAL SIZE).

1. *Alcyoncellum speciosum.* 2. *Euplectella aspergillum.*

to bear on the nature of this "sponge-flesh"—as the living matter is also called—that "flesh" is seen to be disposed in a very defined fashion. It is seen to be made up of small masses of protoplasm, each possessing a kind of distinct individuality of its own, although merged, more or less closely, with the substance of its neighbours. In many cases, the living units of the sponge can be distinguished to exist in the likeness of masses of protoplasm, which continually alter their shape, like the animalcule known as the *Amœba.* In other cases, the separate living particles resemble other animalcules, which possess a curious collar and a whip-like lash or *cilium,* which is in continual movement. A sponge, as to its living parts, in fact, is thus seen to be a *colony of animals*, and not a single animal. The members of the colony constitute collectively a mass of living protoplasm. In its simplest guise, the living colony is a mass of minute particles of protoplasm, aggregated together, and connected by the skeleton they secrete. A curious feature of sponge-life is therefore found in this latter fact: since we discover that we are dealing, in the case of a sponge, with no ordinary or single being, but with a colony of curious forms; or, indeed, it may be with several colonies united to form one living mass (Fig. 1).

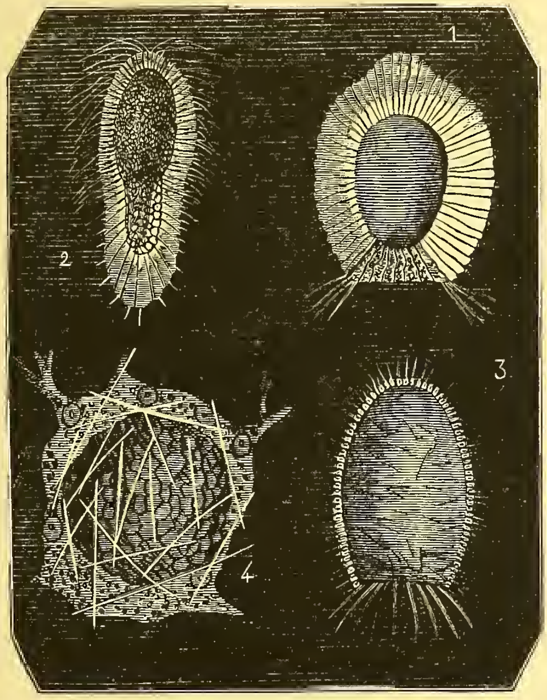


Fig. 2.—YOUNG SPONGES.
1. *Verongia rosea* (horny). 2. *Halisarca lobularis* (gelatinous). 3. *Isodyctia rosea* (flinty). 4. *Sycandra raphanus* (limy).

Viewed from the outside, a living sponge seems to present no sign of active life. It may be torn in pieces without showing the slightest sign of sensation, not to speak of "pain;" and, to all appearance, none of the characteristics of animal life are to be seen in its history. But if we strew some particles of coloured matter in the water in which a living sponge resides, we may readily discover that the ways of sponge-existence are, after all, not quite so silent and inactive as we might be led to suppose. We then become aware that ceaseless currents of water are drawn into the sponge, and that like currents continually issue from it. We further notice that the currents enter the sponge by the small holes, called *pores*, and leave it by the large holes, or *oscula.* Many sponges have but one large aperture or *osculum*, and the "Venus' Flower-Basket" and the "Cup Sponges" exhibit this latter peculiarity. When we reflect that the sponge-canals are lined with living particles, and that these living beings, members of the sponge-colony, require to be fed, the reason for the circulation of water that is ever passing through the sponge is not far to seek. But the fact that this constant circulation of water is required to bring food-particles and oxygen gas to the little individuals of which the sponge is composed does not explain *how* the circulation itself is carried on. To discuss the means whereby the sponge carries on its circulation requires that we should make the acquaintance of its internal structure. In an ordinary sponge, and lining the canals here and there, we can detect little groups of the living particles before mentioned, and which possess the lash-like *cilia* already alluded to. Imagine a canal, and suppose that on each side of the canal a half-moon-shaped space was excavated. Then, if we further suppose that this space was lined with lash-like threads attached to particles growing on the sides of the space, we may form an idea of the so-called "chambers" found deep down within the substance of the sponge. It is by the movements of these "lashes," acting like so many brooms, that the currents of water are swept into the sponge, and swept onwards and outwards as well. This curious disposition of matters, then, seems to remind us that a sponge is by no means such a simple organism as many persons might be led to suppose. On the contrary, we see that in the sponge there are certain of its living elements set apart for special duties, and such a feature foreshadows the same kind of "division of labour" which we see represented in higher life.

One of the most convincing proofs that a sponge is a true animal is to be found in the manner of its development. Like other animals, the young sponge arises from an *egg*. Deep down in the substance of the sponge these eggs are developed, each egg appearing to be formed by some special process from an ordinary living particle of the sponge. This egg soon divides into a great number of small particles, or "cells," and these arrange themselves ultimately to form a double layer or skin, enclosing a central hollow (Fig. 2). The young sponge in this way comes to resemble a cup, and in the so-called "cup sponges" it roots itself to a rock, and "pores" being formed in the walls of the cup, water passes into its interior and escapes by the mouth, the little lashes, or *cilia*, discharging their brush-like duty as already described. But new sponges also grow from what are called "sponge germs," in addition to arising from eggs. A sponge-germ is a curious little body, enveloped in a peculiar case, and developed within the substance of the parent sponge. This germ appears to remain imbedded in the parent-substance during the winter, but when spring-time arrives it ascends to the surface of the water, and allows the little particles, or "germs," to escape, each becoming converted by growth into a sponge.

Sponges possess a wonderfully curious history, both as regards their *habits* and as regards their first life on the globe. Certain sponges bore into the substance of shells by means of their little flinty particles. All sponges, except the solitary *Spongilla*, are inhabitants of the sea. Most of them inhabit deep water, and the flinty sponges in particular are only met with in the abysses of the sea, whence the dredge of the explorer has recalled them to the knowledge of mankind. Very interesting is it also to discover that in the oceans of the past sponges lived and grew much as they exist to-to-day. It is probable that the familiar horny sponges of our houses are a newer race, but this is at the best but supposition, for these soft sponges have left no traces of their history as fossils in the rocks. To-day, around our coasts, pieces of horny sponges are dredged in considerable numbers, although it is to the warm and tropical seas that we look for the sponges which are serviceable to us in our households. The Syrian sponge-divers are amongst the most noted of sponge-finders, and the Greek divers are also famous. The Bahama sponge-banks are well known as a fertile field for sponge-fishing. Again, from minute sponges to the great "Neptune's Cup" Sponge, we have every variety of size represented in this class. So that, turn where we will, we find sponge-history to be full of interesting and wonderful details. It is immaterial whether we think of a living sponge as a kind of "submarine Venice," with its curious canals and waterways, or whether we study the development of the sponge—each detail but adds to the interest with which this group of beings, low in the animal scale, must be regarded by all who study its history.

THE "STONE RIVERS" OF THE FALKLAND ISLANDS.

IN the Falkland islands—East Island especially—many of the valleys are occupied by pale grey glistening masses, from a few hundred yards to a mile or even more in width. At a distance, these have all the appearance of glaciers coming down from the heights above, and gradually increasing in volume as they are fed by smaller glaciers from the side valleys until they reach the sea. When the traveller closely examines them they are found to consist of vast accumulations of blocks of quartzite, some of these blocks being small, whereas others are ten and even twenty feet long, by about half that in width, and of a thickness corresponding to the strata of the same rock in the ridges above, whence they have undoubtedly been derived. They are found to be slightly worn at the points and edges, but their upper surfaces are smooth and polished, and overgrown with a very thin, hard, white lichen, which gives them the appearance of being covered with a thin layer of ice. As the visitor stands on these he can hear far below the sound of running water. As usual, the formation of these wonderful features has been attributed to the all-powerful action of ice, but it is now generally attributed to another cause, which, until recently, has not been much taken into account by those who have investigated the causes of the changes in the earth's surface.

It seems now to be pretty generally agreed that wherever there is a slope, be it ever so slight, there is necessarily a movement of the vegetable mould, or soil-cap, towards the lower part of the incline. Traces of this have been found in the Highlands of Scotland and elsewhere. And it is fairly concluded that, as the dreaded *avalanche* is the final catastrophe of ice movement, so the *land-slip* is usually the final catastrophe of the movement of the soil-cap.

In the case of these "stone rivers" the process seems to have been as follows. The beds of quartzite in the hills are found to be of very different degrees of hardness. Some are soft, approaching a crumbling sandstone in their nature; others are of extreme hardness. The softer kinds are worn away in process of time, and the harder quartzites are left as long projecting ridges along the crests and ridges of the hill-ranges. The process of disintegration having attained a certain point, these overhanging masses give way in the direction of their joints, and the fragments fall gently over on the slight slopes and become covered with vegetable mould. Once entombed in this soil, there ensues in the spongy mass a constant expansion and contraction, as it becomes saturated with water or becomes comparatively dry.

When the expansion takes place the blocks slip down—through an infinitesimal degree perhaps—but they slip through some distance, and the subsequent contraction is insufficient to pull them up again, owing to their size and weight. The rain-water trickling down the slope gradually removes every movable particle from before them. The vegetable soil on which they rest is also undergoing a perpetual process of decay in the interstices, and is in time removed. In this way, then, the blocks are borne down the slopes and piled in the valleys beneath. The stream, altering its course from time to time, has removed all traces of earth from their under and upper surfaces, and left them bare. In this way, then, it is probable that these grand "moraines," or "stone rivers," have in the lapse of ages been formed, and to-day they constitute a veritable "wonder;" at all events they are a very exceptional and very interesting phenomenon.

EFFECTS OF MUSIC.

MEDICAL investigations have been frequently directed to the powerful influences music exercises through the mind upon the body. By increasing mental energy, or by its depressing influence upon the feelings, begetting despondency, music affects the health to a very considerable extent. Many instances might be quoted from ancient history and from the sacred writings, but it will suffice to mention the record of songs devoted in ancient Egypt to the promotion of virtue and morality in the education of youth; to the records which attribute the barbarism of Cynœthe to the neglect of music, and the refinement and purity of Arcadian manners and customs to a love of music; and to point out that a cure was sought for the derangement of Saul by David's playing upon the harp. Pythagoras commended music in the treatment of the insane; and Thales, when a pestilence ravaged Sparta, found in music his most powerful means of combating it. Xenocrates soothed maniacs by it, and Theophrastus held that even the bites of venomous reptiles were rendered less mischievous by subjecting the victims to the influence of melodious remedies. When physicians recognised evil spirits as the causes of disease, music was held to be curative, and Luther expressed the same belief when he wrote, "Music is one of the most beautiful and glorious gifts of God, to which Satan is a bitter enemy."

When Philip of Spain was in so morbid and desponding a condition that he neglected his person and refused to see or be seen by his subjects, Farinelli, the vocalist, was sent for by the Queen, with a party of musicians, to sing and play in the room which adjoined that of the King. The effect was a speedy and rapid cure. Philip listened to him with pleasure, desired his presence, bade him ask from him anything in reason as a reward, and at the request of the singer consented to be shaved, washed, and to appear in public. Both Bruckman and Hufeland relate instances in which music cured cases of St. Vitus's dance, and Becker and Schneider demonstrated practically its influence in different hypochondriacal and hysteric cases.

A very strange story of the wonderful power of music is told by Roger. A criminal dying on the wheel in great torture met the pleadings of the priest by a fierce outburst of blasphemy. Some itinerant musician passing by was requested to play to the sufferer some solemn air, and, doing so, rendered him tranquil, and so changed both his feelings and sentiments that he entreated the forgiveness of the priest, and begged that he would receive his confession.

It is a curious fact, we believe, that musicians who have gone mad often recollect and can play perfectly the airs they knew when sane, although every other memory and acquirement has passed from them.

Sir Henry Halford has chronicled the case of a mad Yorkshireman who was restored to sanity by the use of a violin. Six weeks after its introduction he was cured.

Mr. Nathan has recorded the curious fact that a pug dog in his possession would frisk actively when light, merry music was performed, sit perfectly still when a slow melody was heard, and howl and yell piteously if a certain discord was struck. Eastcourt says when some choristers were singing on the banks of the Mersey, a hare was seen to steal from its retreat and listen, retiring as the voices grew silent, and reappearing directly the singing recommenced. The story of Bossuet about an officer imprisoned in the Bastille whose flute-playing brought out mice and spiders and rendered them tame, is well known. Chateaubriand describes rattle-snakes in Upper Canada which were kept under control by musical sounds.

THE FIRST AMERICAN SILK DRESS.—One of the most remarkable silk dresses on record was on exhibition at Philadelphia in 1882, and was afterwards presented by the American Women's Silk Culture Association to Mrs. Garfield. It was the first silk dress made from the cocoons of American silkworms. The raw silk was grown in fourteen States of the Union by twenty-six families. It was reeled on a Yankee reel, and manufactured in New Jersey. In the quality of the silk and the manner of manufacture it is said to challenge comparison with the products of Lyons looms. Already there is growing in America a demand for duty on raw silk high enough to protect the American silkworms against the competition of China and Italy.

A WONDERFUL AGATE.

THE stones known as agates are in reality composed of layers of flint or quartz deposited in more than usual tranquillity, and consequently with greater regularity. The stratification shows chiefly how layer has been added to layer, and the result is usually a more or less banded or variegated pattern, as in Fig. 1. Occasionally filaments of moss or other vegetable growths are embedded in a more or less clear stone, which is then called a "moss-agate." Such an agate is shown in Fig. 2. Both of these kinds of agates are occasionally found exhibiting figures of great complication and beauty, and are often set in brooches or used for other ornamental purposes.

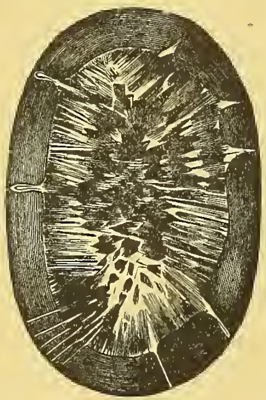
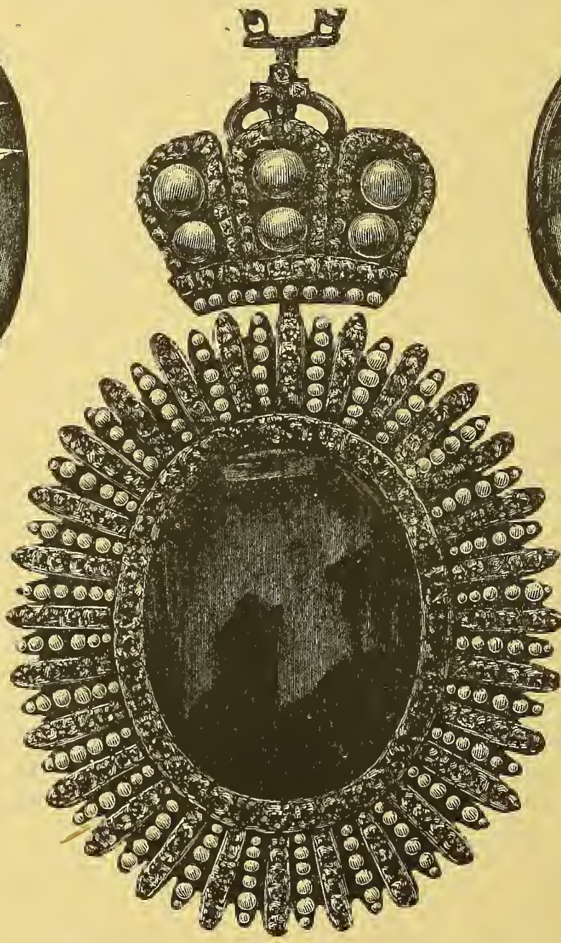


Fig. 1.—AGATE.



MOSS AGATE IN THE MONASTERY OF TROITSKY SERGIVSKY.

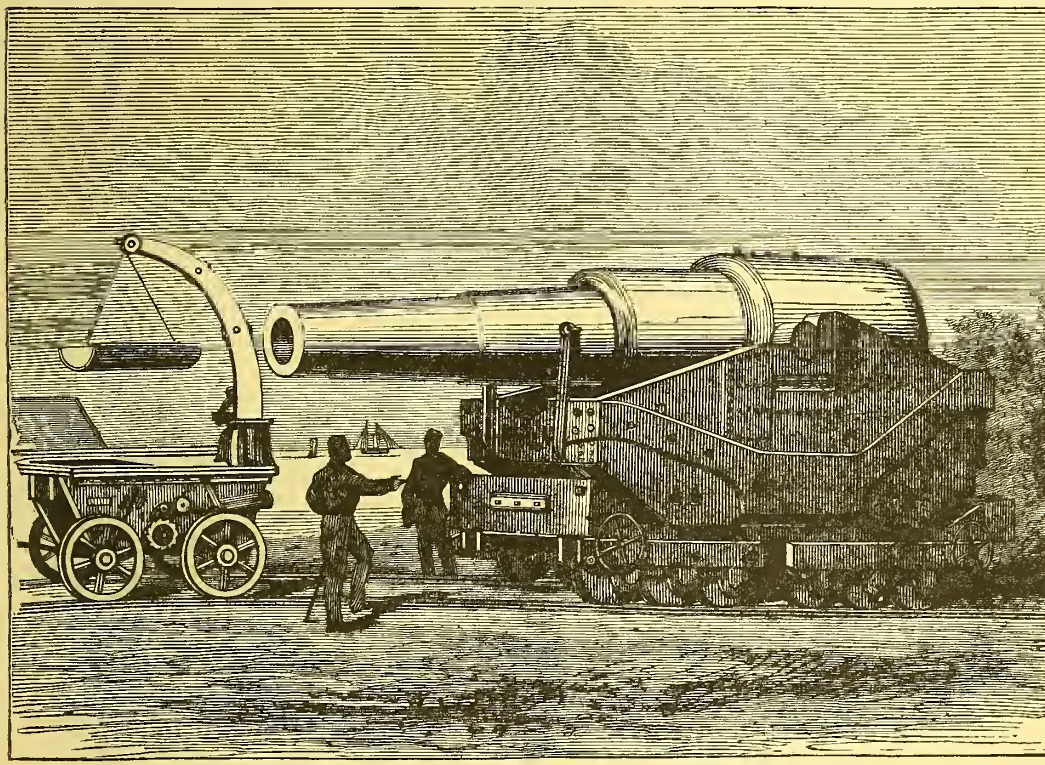
Fig. 2.—MOSS AGATE.

Probably the most wonderful variegated or moss agate in the world, however, is that shown in the illustration above, which is drawn from a photograph, and represents a sacred jewel preserved in the famous old Troitsky Sergivsky monastery at Moscow. The centre-piece is a moss-agate of the size shown, the pattern of which shows with wonderful clearness the figure of a monk kneeling in adoration before a crucifix. So striking is this natural picture, that it has been suggested it may have been a little heightened by artifice ; but there are no signs of this, and we have it on the authority of the present Archimandrite that the stone has been closely examined out of its setting by various skilled mineralogists, both native and foreign, who have pronounced it a purely natural growth.

This remarkable agate was found in Siberia in the eighteenth century, and presented to the Empress Catherine II. of Russia, who in turn gave it to her favourite, Platon, Metropolitan of Moscow. The latter wore it as a sort of image or charm, suspended round his neck by a gold chain such as is worn by bishops, together with a cross, very much in fact as now shown in the illustration. On his death, in 1812, Platon in turn bequeathed the stone to the monastery, of which he was titular Archimandrite, and upon which he had spent much money in various ways, which has caused his memory to be cherished with much veneration, his rooms being still preserved in the same state as when he last used them. The monastery dates from the beginning of the fourteenth century, and Platon's apartments contain the best and most authentic series of portraits of the imperial family, which invests it with considerable interest. But of all the articles given during his life or bequeathed at his death by their former superior, none is held in such veneration for its own sake as this wonderful stone.

OUR GREAT GUNS.

GUNPOWDER, guns, and the rudimentary mechanical forces were no new things, yet in their dexterous manipulation, improvement, and application, it was reserved for the nineteenth century to accomplish the most astonishing combination of these forces for practical purposes which the world has ever seen. This remarkable state of things was not, however, brought about at a bound. Carronades which would carry 2,000 yards are spoken of invented by Thouvenin, and consisted of a short pillar of steel (hence named the "pillar rifle"), concentric, with the barrel screwed into the breech of the gun, round which the powder was disposed. The practice made by this rifle established the vital excellence of the conical form of ball. The later invention of M. Minie consisted of a conical bullet expanding into the grooves of the barrel on the gunpowder exploding, and not, as in the first essays in rifling, being forced into the grooves by the soldier's ramrod.



THE WOOLWICH 81-TON GUN.

by Eldred in "The Gunner's Looking-glass, 1644." The idea of rifling cannon is by no means new. A German experimentalist, Rütter of Nurnberg, more than three centuries ago (1520), invented a kind of rifled artillery with spiral grooves, and Robins, the inventor of the ballistic pendulum for determining the relative velocity of projectiles, experimented on rifled field-pieces in England as far back as 1745. But the practical outcome of these inventions was nothing.

During the exhaustion which followed the great struggle of the French wars, nothing much was done, nor until after the siege of Antwerp, in 1832. Then the first improvements were effected in France. The first rifle in vogue there was

The efficiency of the Minie rifle having been established, it became apparent that improvements in heavy ordnance must of necessity follow the small arms. Private firms began to make experiments, notably Messrs. Morgan and Holroyd of Bristol, and Mr. Armstrong of Newcastle. In 1854 the latter gentleman placed his proposal for the improvement of artillery before the Minister of War, and during the succeeding four years he was permitted, as an indulgence, to carry on a series of experiments at his own expense (in the first instance), the results of which were simply astounding. Merely in the matter of range (which, it must be remembered, is nothing without its concomitants, *precision* and *penetration*), he made and sent to Shoeburyness a gun carrying a shot 9,000 yards, or more than *five miles*. Armstrong manufactured his gun of ribbons of carefully-prepared metal, wound spirally round a mandrel, and welded by being struck perpendicularly in the direction of the barrel. Sometimes the mandrel was replaced by a steel cylinder, which formed the centre, and the outside was reinforced by one or more cylinders shrunk on and welded. With some modifications (for the most part intelligible only to the artillerist), the guns now manufactured at Woolwich are types of the above weapon. Other inventors moved up as competitors, but none of them held their ground. There was Lancaster, with his elliptical bore; Whitworth, with his hexagonal bored steel guns with cylindrical bullets; Palliser, Scott, Boxer, and others of lesser note. The powder to be used with these guns had to be of a very superior quality to that known as service powder; but this fact was for a long time ignored by the English gunners, which tended to retard the perfecting of the new system.

Whitworth's theory was, that difficulties which arise from the length of the projectile are overcome by giving sufficient rotation, and that any weight that may be necessary can be obtained by adding to the length of the gun and reducing the diameter, thus obtaining a comparatively low trajectory (or curve described in the passage of the shot); he laid great emphasis on the effect of a proper rifling turn, and the consequent rotation given to the shot, on which its power and penetration very much depended. At first, several guns constructed on the Whitworth principle burst on test; the same thing happened to many of the steel guns manufactured by Krupp, the German gunmaker, of Essen. Whitworth, however, claimed that the superiority of his steel gun over the iron guns was that a gun of a given calibre was more effective than a service gun of larger bore: in fact, that his three-pounder muzzle-loading gun was superior to the service six-pounder breech-loading gun. These details are necessarily given with some prominence, because the contest for superiority or Government favour has been really narrowed to Messrs. Armstrong and Whitworth, who are at the same time eminent engineers, and it is well to bear in remembrance the points of difference between them. There are still differences of opinion amongst professional men and specialists as to the best methods of constructing guns; the best metal, or combination of metals; whether a gun should be formed of cast tubes of steel pressing one on the other, or of a tube of wrought-iron strengthened with an outside coating of steel, or with an interior formed of massive steel enclosed in rings of steel, or an iron interior enclosed in hoops of steel. It can hardly be said that the whole of the points have been yet solved. The Government has probably secured a good gun; but the main question is, Will one description of gun answer for every description of work?

A breech-loading Armstrong presents an external peculiarity which has struck most people, namely, the thickness of the gun at the breech. The reason for this happens to be a reason which is obvious to the untrained eye, namely, that there should be the greatest strength where the projectile receives its first impulse, and where the gas is generated which propels it. When firing at long ranges, with large charges of powder exploding, it was found that there was great strain upon that part of the gun, and the inventors had consequently to provide for the greater material strength of resistance being lodged there.

Early inventors had a very imperfect knowledge of the correlation between the gun, the shot, and the explosive. Quite recently it has been found that the velocity imparted to a projectile depended upon the rapidity with which powder disengages its gases. Slow-burning powder, surprising as it may sound, is better than quick; and there is no more wonderful process in science than that by which it can be ascertained that an 8-inch gun firing a cylindrical shot of 180 lb. with a powder-charge of 30 lb. R. L. G. (large grain powder), that starts the shot with a spring, imparts a velocity of 360 feet per second, whereas the pebble powder, a very superior description, imparts a velocity of only 80 feet per second in the first inch, but in the course of forty inches the pebble powder is found driving its projectile with greater speed, so that it finally leaves the gun at a velocity of 1,580 feet in one case, and 1,320 feet in the other. It has also been found that the power to resist with safety the sudden application of a given pull requires twice the strength that is necessary to resist the gradual application of the steady action of the same pull; hence a rapid explosive occasions more strain upon the chamber of the gun than the slower one.

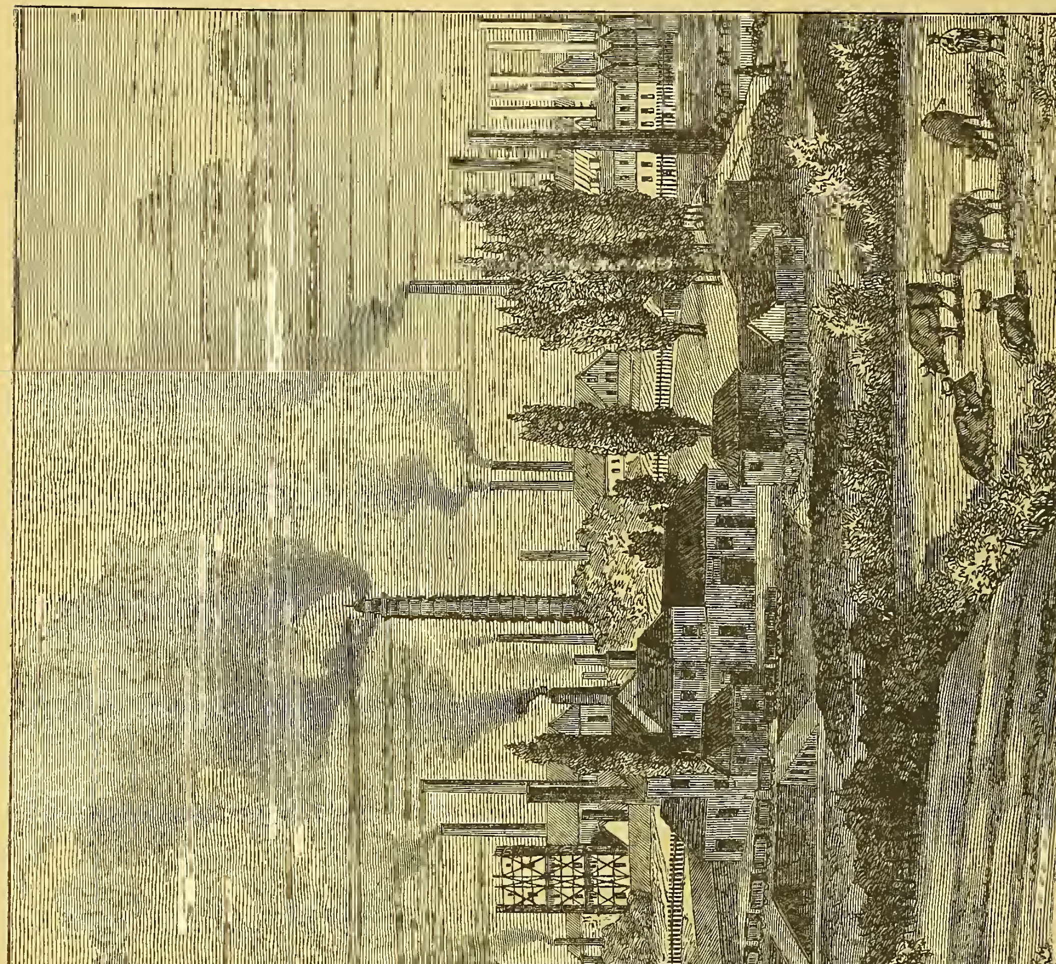
The Woolwich guns on the whole answered admirably. From weapons of 7 tons, rapid strides were made to 9, 12, 18, 25, 35, 80, and 100 tons, all of the finest fibrous iron. In 1875 we find an 81-ton gun in course of manufacture at the Royal Arsenal, Woolwich. The rifling of the bore was carried out at the boring-mills; the whole process, down to the shrinking on of the trunnion-ring, was effected without any accidents, except fracturing the face of the 40-ton hammer in welding together the breech-coils. Yet the machinery was confessedly adapted only to a gun of half the weight. This gun is shown in the illustration, but in point of size it was entirely eclipsed by the artillery monster, the 100-ton muzzle-loader gun of 1881. These latter guns, it is scarcely necessary to remind the reader, are not intended to be moved from place to place, but to occupy fixed positions on forts, castles, and other fortified places. Considering their enormous weight, it would be utterly impracticable to do so.

In September, 1881, we witnessed the test of the guns of this calibre which were about to be sent on service to Gibraltar and Malta. On account of the expense, the test was limited by the War Department to the firing of five rounds; the powder-charge on that occasion consisted of 448 lb. of the most recently approved (powder) pebbles, each about one inch diameter, and systematically arranged in four cartridges, with means of communication at the end. The projectile was a flat-headed proof shot of 2,000 lb. weight, or about four-fifths of a ton. The concussion is tremendous, but not so hard to be endured as might be supposed, nor so bad as the ring of a brass gun, which sometimes caused blood to start from the men's ears. This gun is 34 feet in length, and tapers down from $6\frac{1}{2}$ feet at the breech to a diameter of $2\frac{1}{2}$ feet at the muzzle. The diameter of the bore is $17\frac{3}{8}$ inches. The price paid for each of these guns is £16,000; for the manufacture of the prismatic kind of gunpowder the Government pays one shilling per pound. The total cost of each round is in the aggregate £30. Some conception may thus be formed of the outlay of treasure which anything like a protracted siege of our "strong places" will in future involve, and even furnish some political reasoners with a new argument against their retention. Although on the occasion we are referring to one hour was consumed in firing three rounds, yet with a well-drilled gun detachment it is considered that the operations could be performed in about twenty minutes. The projectile used (a proof shot) was fired at a velocity of 1,570 yards, and struck with an energy of 33,500 per foot-tons at the muzzle, so that at a mile range it would destroy three-foot armour. There was very little strain upon the gun, the pressure created by the improved powder being uniformly below 15 tons to the square inch.

The manufacture of the rifled guns is a very complicated process. The bars of iron which are used are long; the transverse section is not rectangular, but wedge-shaped, with the apex cut off. The bars are converted into cylinders. The inner tube, which is the first part made, extends the whole length of the gun, and is composed of several cylinders, called in the factory coils, each coil being made of a single bar, cut to the required length. A long low furnace is heated, and the bar placed in it; when it has attained a red heat it is passed to the coiling-machine, erected conveniently close to the furnace. This is a solid mandrel, or roller, revolving on pivots in the head of two upright posts, and it turns by machinery; one end of the roller is slightly "coned," *i.e.*, one end larger than the other, so that the coil may slide off. The heated bar is withdrawn from the furnace, and by means of a hole fitted on to a pin in the side of the mandrel, which is set in motion, the bar is rolled up, and becomes a cylinder. In order that the bar may coil properly round the mandrel, it passes along and over a rest between the furnace and the machine, so close to the latter that the iron is forced to bend in the direction of the coiling; a few blows on the end from the hammer, and the coil is complete. The mandrel is then hoisted on end, and the coil runs off: if it were allowed to cool on the roller, it would probably adhere to it. The coiling is the principal feature in the manufacture of the gun. The method of arranging the iron so that its fibres shall be in the direction of the circumference imparts a strength that could not be attained by cast-iron. The next operation is that of welding the spirals of the coil together, so as to form a cylinder, for however close it may be coiled, the coil shows shrinkage and interstices. The coils are taken to another workshop, and then, when nearly at a white heat, are shifted from the furnace, placed on end beneath a powerful steam hammer, and by rapid blows the whole of the spirals welded until they become one. The coils thus forged are taken to the turning-lathes, smoothed, and finished both inside and out. Two or more coils are required to finish the inner tube.

Now commences what is termed technically the building-up of the gun. The inner tube is left rather too large for the outer, but the outer one is heated until it is expanded sufficiently to let the first one pass into it; when cold, both are so firmly joined together that it is impossible to separate them, and thus each successive coil is "shrunk on" until the building-up is complete. The breech-screw is a solid forging, bored out to the requisite diameter, and turned with a screw on the interior. The vent-piece is a block of wrought-iron, with a neck to it, which serves as a handle to lift it out; the reason of making the vent-piece thus is that it is the part of the gun which sustains the most wear and tear, and it is now the part most easily replaced under this arrangement of construction.

Whilst we write there are some new breech-loader guns being manufactured at Woolwich of 43 tons (12-inch), 26 tons (10·4-inch), 18 tons (9·2-inch), with others of smaller dimensions. All these guns are "built up" according to the most improved system of construction, steel being liberally used. The guns are rifled on the "polygroove" system, the "twist" being partly increasing and partly uniform. All the guns have enlarged powder-chambers capable of burning heavy powder-charges of slow-burning powder, and very high muzzle velocities are realised. The entire series of these new type guns will shortly be issued to the naval and military services. The weapons that are turned



KRUPP'S FACTORY AT ESSEN.

out, whether the mammoth ordnance of 100 tons or the 9 and 10-inch guns, are of tested value. At the recent bombardment of Alexandria, we are told that the old smooth-bore guns did little but rattle their shot against our ironclads, but the rifled guns pierced the armour in many places wherever it was weak. The Armstrong rifled pieces hit the ships severely between wind and water.

Krupp's gun-works, which stand to the Germans in the same relation as Woolwich factory does to us, are situated at Essen, and are carried on upon an enormous scale; they occupy about 450 acres of ground, one-fourth of which is covered. Some time ago (and we are not aware of any great changes) he employed 8,000 men, besides 2,000 in the coal-mines at Essen. At the blast-furnaces on the Rhine, at the iron-pits on the Rhine, and at Nassau, he produced in 1860 61,000 tons of metal by means of 112 smelting and cementing furnaces, 195 steam-engines from 2 to 2,000 horse-power, 49 steam-hammers with blocks of from 10 to 50 tons, 110 smiths' forges, 111 planing-machines, and 61 cutting-machines. Most of the guns made there are from 4 to 300-pounders. At the Paris Exhibition he exhibited a 1,000-pounder weighing 50 tons, and a 330-pounder weighing 12¼ tons, breech-loaders. The 1,000-pounder was afterwards presented to the Emperor, then King of Prussia. It was a type of many, having a forged inner tube strengthened with three layers of rings over the powder-chamber, and two layers over the muzzle portion. The rings were forged from ingots, without welding. The manufacture of this gun would appear to have been quite a sensational matter, as it occupied sixteen months day and night, and cost about the same price as was allowed Sir W. Armstrong for his 100-ton guns, or £15,750. The loading arrangements are very complicated—quite unsuited to the ordinary English gunner—and a great deal of time is consumed in going through the various parts of the loading.

THE POWER OF IMPUDENCE.

A CASE of swindling brought before the Assize Court in Paris on September 21st, 1814, is worthy of record as an instance of daring impudence wonderful in every way, whether regarded in connection with its perpetrator or his victims. From the trial we glean the following particulars. A young Jew, named Joseph Wallerstein, eighteen years of age, and a sergeant-major of sharp-shooters in what was then called "the Old Guard" and had previously been known as "the Imperial Guard," after the battle of Brienne procured his discharge, and went home to live with his parents at Paris. At that time the attention of all Europe was attracted to Russia, and it struck Joseph that a Russian prince, especially if he happened to be nephew to the Emperor Alexander I.—the great champion for popular rights in all countries except his own, and not excluding Poland—would create a sensation in Europe, and especially in France. He knew a little German, had fought in the Russian campaign, and had an amazingly large amount of impudence—why should he not become that Russian prince? Seeing no reason why, he took up his abode in the house of Galisen, the *traiteur* of the Boulevard du Mont-Parnasse, as Baron Count Komburnski Kanduruski Padoroski, a colonel of Cossacks, commander of the chasseurs of Frieldberg, and aide-de-camp and nephew of the Emperor of all the Russias, newly arrived in France. He was so condescending, so patronising, so ready to promise protection and honour to those who proved themselves either pleasant or useful to him, that his fame sprang rapidly into being and spread with proportionate speed. He hired a carriage while his own was being built; he gave hatters, tailors, and even pastrycooks and confectioners orders on his treasurer, instead of money, in return for the goods they were eager to supply. He dressed with simple elegance, and never was vulgarly ostentatious, commonly in a green riding-coat, and his retinue was dispensed with in order that his Highness might be waited upon solely and exclusively by a single favourite attendant.

When it was announced at the Hotel des Invalides that the great Russian prince then travelling unceremoniously through France was coming on a certain day to visit that asylum of the brave and honourable, it was determined there that he should be greeted with such a reception as was due to the nephew of so popular a ruler. He was received with all due state and ceremony, shown the dome and the sacred military relics, and a repast was prepared for him in the decorated refectory, at which the health of his imperial uncle and his own were solemnly proposed and enthusiastically drunk. The "prince" took one of the decorations from his button-hole, and with much feeling persisted in bestowing it upon the officer who had organised this grand reception, but who hesitated in accepting it—the brave man was so modest. Another officer, who presented the prince with his silver snuff-box, was not a little gratified when the royal Russian requested leave to retain it "as a memorial of these brave men and this memorable visit," and in order that he might replace it with one made after it in gold. He also expressed a very urgent desire to leave with these brave old warriors, whose blood had enriched so many soils, some token of the honour and reverence with which he regarded them; but as this was expressly forbidden in the laws of the institution, he was compelled, with profound regret, to abandon his generous intention.

Before he left he remembered certain purchases he had to make, and inquired where he could obtain change for some Russian notes. The General who had been prominent in welcoming him to the holy soil of France in the name of the people and Liberty, regretted his inability to definitely answer that question, but begged that his Imperial Highness would condescend to make use of his purse and its contents, to do which his Imperial Highness at last reluctantly consented. "Unfortunately," said the General, "it contains but twenty gold pieces."

The prince resided for some time at Meudon, where he lived on the best and kept an excellent table, to which all kinds of distinguished people were welcomed, and all at the cost of a credulous innkeeper, who was delighted and proud and greatly honoured in being permitted to provide with such princely liberality.

Entering Versailles, he perceived an old soldier wearing two orders, and, dismounting from his horse, embraced him. Asking what orders he wore, and learning that they were those of St. Lazarus and St. Louis, he explained to the old soldier of the king his own name and rank, overpowered by which, M. Belmare de St. Cyr, the soldier in question, invited the prince to his house, where he entertained him at dinner, after which he was solemnly created Grand Commander of the Order of Malta, and was duly adorned with a blue ribbon. It was not until long after that the gallant old chevalier remembered that there was no such dignity as that he had received, and that the cordon of Malta is black! Madame de Belmare was highly delighted with the young stranger, and finding that he was slightly inconvenienced by the difficulty of procuring change for Russian paper money, pressed upon him, as a trifling loan, a purse containing one hundred francs, humbly apologising for the smallness of the sum. He solicited the honour of presenting this lady to his imperial uncle, who had, he said, just arrived in Paris.

Speaking of French and Russian watches, the prince expressed his surprise at the superiority of French time-keepers over those of his own country, whereupon M. de St. Cyr introduced him to his own watchmaker, of whom the supposed Russian purchased a costly watch and chain, smilingly directing the tradesman to come to him at Meudon on the following day for the money, and to bring with him other watches, for which he pleasantly said he would undertake to find purchasers. On this occasion he spoke of himself as Governor of Meudon.

Just before he met M. de St. Cyr he had encountered and entered into conversation with a military officer who heard of his name, rank, and lofty pretensions with evident scepticism, and refused to be patronised by him. This gentleman he met again on the evening of the same day, when, in company with his newly-made friend St. Cyr, he strolled into a café. The sceptical one was in conversation with the watchmaker, whose looks as he hurried up to him and said he must have back there and then either his money or his watch were most alarming. He preferred, he loftily said, returning the watch, and desired the tradesman not to visit him at Meudon, and not to betray his *incognito*. He then hastily bade M. St. Cyr adieu, mounted his horse, and galloped away to Meudon. The sceptical military man also mounted his horse, and followed him.

At Meudon a grand banquet had been prepared, and many guests were assembled awaiting the arrival of "the prince." Having ascertained this, the sceptic grew puzzled and retreated.

Some days after, the Mayor of Pont Saint Louis was visited by the illustrious stranger, who gravely desired him to collect forage and provisions necessary for the arrival of the Emperor of Russia at St. Maur at ten o'clock that evening. His uncle, he said, would bring a guard of eight hundred cavalry. He had already been to seek the Mayor of the commune Saint Maur, but unluckily that worthy citizen was from home. The Mayor of Saint Louis asked for a written requisition, which was given without the slightest hesitation. The prince afterwards dined with the Mayor, and having eaten and drunken his fill, did him the honour of borrowing his watch, having left his own, he said, with his friend, St. Cyr. He then accompanied the Mayor to the estate of M. Mallet, at La Gàrenne, where arrangements were made for the accommodation of sixty of the Russian guard with lodging and rations, and rode about with him in other directions to hasten on suitable preparations. But before he left M. Mallet he looked at his watch (that he had borrowed of the Mayor), and with an air of great vexation said it was out of order and had ceased to go. M. Mallet politely offered the loan of his watch, which was as politely accepted with gracious condescension. As the required supplies were not obtainable in the given time, at the suggestion of the Mayor he wrote to General d'Aumesil, Governor of Vincennes. While he was thus engaged home came the Mayor of St. Maur, who, being less credulous and more curious, soon grew suspicious, and finally, worming out the story of the watches, gave an order for the arrest of the pretended prince. He was first examined before General Sacken and afterwards by Count Rochechouart, who pronounced him an impostor, and delivered him into the hands of justice.

He was tried for forgery, but his counsel set up successfully a very ingenious defence, proving that the documents he had signed were not such as came within the legal definition of forgery. He was accordingly acquitted! But being tried on the second charge of swindling, he was less fortunate, and was sentenced to five years' imprisonment, a fine of three hundred francs, and to pay all the legal costs of his trial.

A LETTER THREE THOUSAND YEARS OLD.

IN the fifteenth century before Christ, an Egyptian clerk or scribe, Panbesa by name, wrote a letter to a brother scribe, Amenemapt, which is now generally referred to by the learned as "the letter of Panbesa." There is a copy of it in the British Museum, forming part of the collection known as the Anastasi Papyri, a set of documents so called on account of their having been purchased from M. Anastasi by the Trustees of the British Museum. These papyri, of vast age, time-worn and mutilated, are in rolls formed of slices of the papyrus plant, and the enigmatical characters on them have been translated by several learned men during the present century. Panbesa's letter was partly translated in 1855, by the Rev. J. Dunbar Heath; and since then more completely by Chabas and Maspero into French, and by Goodwin into English. It is an extremely interesting letter, not only on account of its antiquity, but also because it deals with a period when the Israelites had probably not as yet escaped from bondage, and it speaks of the very Pharaoh (Rameses II.) who is thought to have been their oppressor.

In old-world characters, Panbesa "greets his Lord, the scribe Amenemapt, to whom be life, health, and strength!" A commencement for a letter not very unlike that now commonly employed by the rustic letter-writer, who "hopes to find" his correspondent "in good health and strength." Panbesa's letter, however, is more of the nature of a literary production than of a private communication, and he accordingly gives an ornate description of the city of Pa-Rameses, where the letter is presumably written. He speaks of its fields "verdant with grass;" of its threshing-floors full of barley and wheat; of the grapes, olives, and figs in the orchards; of its daily market, and of its fish and water-fowl. Pa-Rameses was evidently a city built in a land flowing with milk and honey, and from the topographical details in the letter, Egyptologists have identified it with the Rameses of the Bible. It thus affords strange secular testimony to the fact that this part of the country must have been a fertile one before the new city of Pa-Rameses was built, as mentioned in Genesis xlvii. 11: "And Joseph placed his father and his brethren, and gave them a possession in the land of Egypt, *in the best of the land*, in the land of Rameses, as Pharaoh had commanded." Afterwards, when a new king arose (Rameses II., "which knew not Joseph,"), the Israelites were compelled to make the bricks wherewith to build the city of Rameses, and also of Pithom (Exodus i. 11). This Rameses, built by forced labour, appears to have been a pleasant city for the Egyptians to live in, even if we make every allowance for the hyperbolic language of Panbesa, who informs us that "the lesser folk are there equal with the great folk;" that its maidens were "in holiday attire every day," with locks "redolent of perfumed oil," and they stood in the doorways with nosegays and green boughs during the Royal visit to the city. It is a sweet picture of more than thirty centuries ago, but it is unfortunately marred by the thought that this very king, Rameses II., to whom they were doing homage, although clever and prepossessing, and the builder of several cities, was a cruel despot, who had inflicted on the subject Israelites the severest pain and suffering. He ascended the throne of Egypt B.C. 1410, when he was only ten or twelve years old, and remained on it sixty-seven years.

The citizens of Pa-Rameses had their drinks; there was "sweet wine of Khemi," "pomegranate wine," wine "from the vineyards," and last but not least, "beer of Kati." It is strange to hear beer mentioned in so ancient a document, and these are probably the earliest secular references one can find to wine and beer. In this respect the letter is highly curious and interesting. Nor was there music wanting, for Pa-Rameses had its sweet singers of the school of Memphis.

Such is the general nature of Panbesa's wonderful letter, as presented to us on the Anastasi Papyrus III. It is apparently a poem composed in celebration of the Royal visit to Pa-Rameses, and we have in it a picture of a civilised city, which existed on the confines of Egypt and Canaan more than three thousand years ago, before the western nations of Europe were founded. It is not the least wonderful part of the matter that this poetic record has been handed down to us, not on hard granite monuments with their everlasting graven characters, but on perishable papyrus, which has at last told its tale to our nineteenth-century scholars.

SPECTRUM ANALYSIS.

IN the article on the "Rainbow and the Spectrum" (page 40) it was explained that when a very narrow slit or slice of daylight is allowed to pass through a triangular piece of glass called a prism, the various colours (seen in the rainbow) of which the sun's light is made up are separated from each other, and spread out into a brilliant band of colour called the "Solar Spectrum," which was first discovered by Sir Isaac Newton. Now, this prismatic analysis (or pulling to pieces) of light may be applied to all kinds of luminous rays, whether they proceed from the sun, stars, comets, or nebulæ, or from any terrestrial source of illumination ; and the series of coloured bands (either distinct from each other, or more or less overlapping) produced by the passage through a prism of a narrow slit of light from any given light-sender, is called the "spectrum" of *that light.* For accurate and delicate observations, it is found better not to receive the spectrum upon a screen, as Newton did, but to put one end of a small telescope on that side of the prism from which the rays emerge, and to apply the eye (or a photographic plate) to the eye-piece. Such an instrument is called a Spectroscope, and the simplest form of it is shown in Fig. I. It is usually supported on a tripod stand, T, with two branches, A A, one of which carries a tube, C, at the outer end of which is a slit, D (the jaws of which are adjustable by a screw, so as to give any desired width), in front of which is the light-sender. At the other end of the tube is a lens, which causes the rays from the slit to fall exactly parallel upon the prism (or set of prisms), E, and the light after emerging from this is examined in the telescope, B. In practice the prisms are enclosed in a box, and the whole instrument is so arranged that no light can reach the eye of the observer except that which has passed through the slit, D. When the light-sender is a celestial object, the spectroscope is usually attached to a telescope, but this application of it must form the subject of a separate article. In all good spectroscopes a provision is made for throwing two spectra into the field of view at the same time, in order to compare them accurately. This is done by fixing close in front of either the upper or lower half of the slit a very small reflecting prism, so arranged that while the rays from one light-sender pass directly through the slit, those from the second, which necessarily occupies a different position from the first, are reflected on to the slit, and both sets of rays pass on to the prism to be simultaneously analysed, and to present to the eye of the observer two spectra which he can compare and measure at his leisure, or if necessary photograph on the same plate.

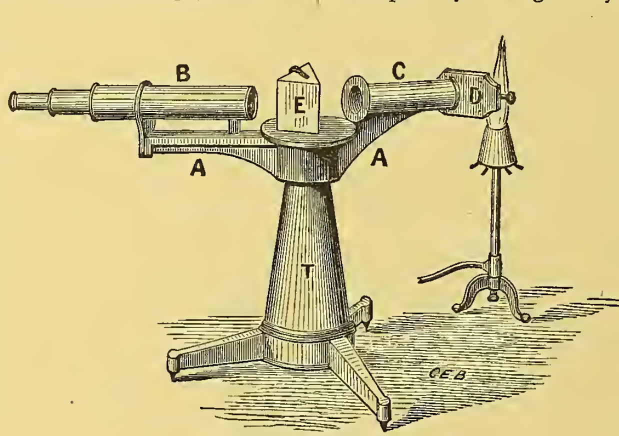


Fig. I.—SIMPLE SPECTROSCOPE.

It may be as well to point out here, as no further allusion will be made to the fact, that a photographic plate gives a much more complete record of spectra than that which is perceived by the human eye; or, in other words, that the photographic spectrum is much longer than the visible one. To understand how this can be, let the reader recall the well-known fact that the human ear varies considerably in its power of perceiving musical tones. Certain *notes* are inaudible to some people, while others hear them distinctly: an observation which applies especially to notes at the extreme ends of the scale, and more particularly to very high notes—a subject which has been specially investigated by Capt. Douglas Galton, C.B., F.R.S., &c. In the case of the lowest note which we can appreciate as music, the vibrations enter the ear at the rate of 16½ per second, while the highest appreciable note (which is not audible to everyone) is caused, according to Helmholtz, by 38,000 vibrations per second. The air is probably teeming with sounds both above and below that range. The roar of Niagara is probably one of the latter class, while the sounds of certain insects belong to the former. In a similar way, therefore, it is possible to conceive of variations which are too rapid to produce in the eye the sensation of *light* (or of *colour*) and are therefore invisible, while they may still have power to effect that change in the sensitive silver salts necessary to permanently record their existence.

Let us pursue a little further this analogy between sound and light. Both are propagated by *wave-motion*—that beautiful disturbance which we can study at leisure in masses of moving water—and in both cases can the size of the waves be measured, as well as the rate at which they are moving. Throw a stone into a mill-pond, and notice how that disturbance is propagated all over the pond by the tiny wavelets that move upon its surface, and mark how each particle of water simply moves up and down (as evidenced by a floating leaf or bit of stick) while the disturbance moves in a horizontal direction. So, exactly, is the propagation of sound and of light. Sound-waves travel through air at about 1,140 feet per second, and the length of those that produce audible sound varies from 70 feet to 3½ inches. Light-waves travel through the air (and through inter-stellar space) at the enormous velocity of 186,000 miles per second. The length of the longest wave that we can see, which produces red light, is about the $\frac{1}{39000}$th of an inch, and the length of the shortest wave that we can see, which produces violet light, is about the $\frac{1}{57000}$th of an inch. (Note, in passing, what a much less range the eye has for light-waves than the ear for sound-waves.) From these figures it follows that 392 billions of waves enter our eye each second in the case of red light, and 757 billions per second in the case of violet light. The ultra-violet portions of the photographic spectrum are due to even more rapid vibrations than these. It will be readily inferred from an attentive consideration of these facts that a spectroscope separates the complex wave-systems of light into their various constituents, and that, as a matter of fact, the wave-length corresponding to any particular portion of the spectrum may be accurately known and measured.

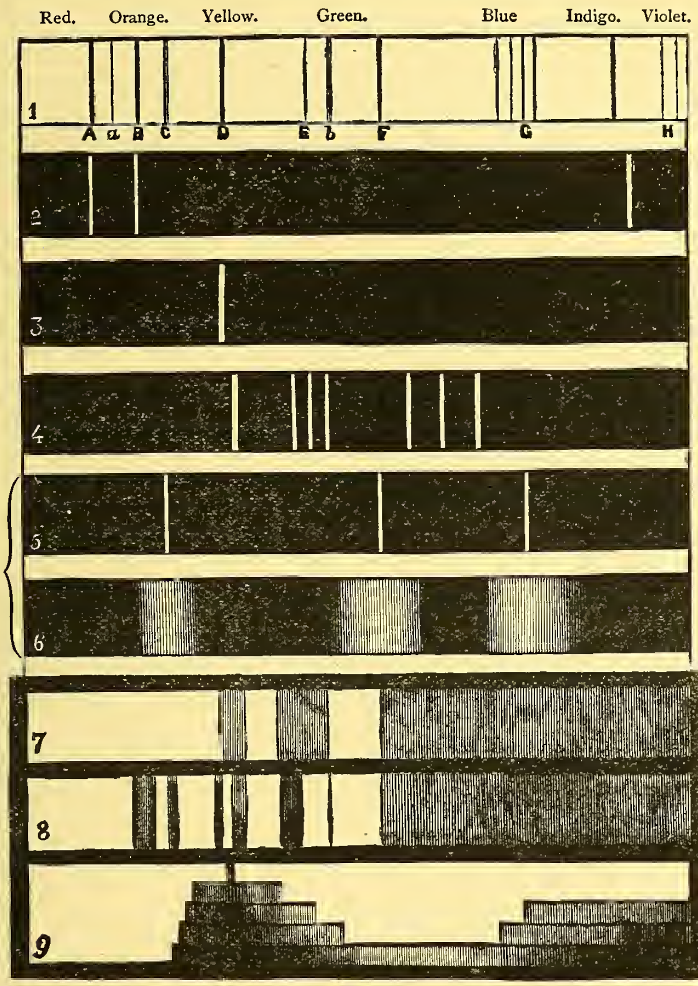


Fig. II.—CHART OF SPECTRA.

1. The Sun.
2. Potassium.
3. Sodium.
4. Magnesium.
5. Hydrogen.
6. „ compressed.
7. Blood.
8. Chlorophyll.
9. Litmus, various thicknesses.

Let us now examine various light-sources more closely, with the aid of the spectroscope, and note the results. The first thing that we shall observe is, that the solar spectrum, the spectra of the electric light, the oxy-hydrogen light, gas, candles, or oil lamps of any kind, are all of one general character, and consist of an unbroken gradation of coloured bands, ranging from the red to violet, thus (No. 1, Fig. II.)—A *a* B C red, D yellow, E F green, G blue, H violet; and we shall be gradually led to the conclusion that all solid and liquid substances (melted metals, for example), when heated hot enough to give out, approximately, white light, yield "continuous spectra" undistinguishable from each other. When, however, we pursue our investigations further, and examine the spectra of the light given out by *gases*, or vapours, which are either burning, or are by any means made hot enough to glow and so give out light, we shall find that these spectra differ from each other very materially, and instead of being continuous bands of colour, consist of isolated bands, separated from each other by intervals of darkness. Yet more, if we carefully note the composition of the light-sender, whether, for instance, it be burning hydrogen, or (as in Fig. I.) a colourless Bunsen gas-flame tinged with the vapour of some metallic salt, a small particle of which may be inserted in the flame, we shall find that each simple substance (or element, to use the language of the chemist) yields a spectrum which is peculiar to, and characteristic of itself, and of no other substance whatever. It follows that any elementary substance may be recognised with absolute certainty by putting it (or one of its compounds) into a flame hot enough to volatilise, or vaporise, small portions of it, and observing by a spectroscope the light so produced. Hence the name given to this branch of physico chemical research, *Spectrum analysis.* Consequently, as the mere examination of a light-sender by a spectroscope is sufficient to show (1) whether the light is derived from glowing solids or liquids on the one hand, or glowing gas on the other, and (2) if it be from gas, what is the nature of (the substance producing) that gas, it is obvious that much may be learnt about the chemical and physical constitution of even the heavenly bodies by the application of the spectroscope to the telescope.

Without the aid of colour it is impossible to give more than a very faint idea of the spectra of terrestrial elements ; but the annexed chart (Fig. II.) may serve our present purpose, if the reader will kindly colour it in imagination, and imagine for example the white band in No. 3 to be a brilliant yellow, the bands in No. 4 to be green and blue, and so on, as indicated by the "colour words" at the top of the chart.

There are two other important points to be noticed in connection with the spectrum of any given terrestrial element, which have an important bearing upon its physical condition. The first is, that the number of bright bands increases with the heat of the vapour, or, in other words, that the complexity of the spectrum increases with the temperature. The spectrum of a metal taken by the electric spark, for example, contains far more bright lines and bands than that of the same metal in a Bunsen gas-lamp. Hence the complexity of a spectrum gives a clue to the *temperature* of the substance. The second point is that the *pressure* to which the luminous gas is subjected causes great alterations in the width of the bands characteristic of that gas ; so that, within certain limits, that pressure can be ascertained merely by spectroscopic observation. This is illustrated in Nos. 5 and 6, where the spectra of hydrogen at different pressures are figured. A third point, applicable not so much to terrestrial as to celestial physics, and deferred to another article, is that a minute displacement of one or more of the coloured bands characteristic of an element is certain evidence, to the spectroscopist, as to whether the light-sender, be it sun, star, nebula, or comet, is moving *from* or *towards* the earth, and at what approximate rate in the line of sight !

Another class of spectra are called absorption-spectra, and are produced as follows :—A continuous spectrum is thrown into the field of view of the spectroscope, and there is then interposed between the light-sender and the slit the substance whose "absorption-spectrum" it is desired to examine. This substance may be either a transparent solid or liquid, or a gas. As an example of the latter, the orange fumes produced when strong nitric acid is poured upon copper may be mentioned. Glass of various colours, and solutions of metallic salts, or of various dyes and colouring-matters, either in water, alcohol, or some other solvent, are examples of the former. When such an absorber is thus interposed, dark bands or lines make their appearance in the continuous spectrum, telling us of certain waves or sets of vibrations of which those substances have robbed the light in its passage through them. These absorption-bands are, as a rule, characteristic of each substance, and by applying the spectroscope to the microscope Mr. Sorby was able to recognise with certainty the absorption-bands produced by the colouring - matter of a single blood - corpuscle. Examples of these absorption-spectra are seen on the chart, Fig. II. The shading on No. 7 shows the position of the absorption-bands produced in a continuous spectrum (either of solar or lamp-light) by diluted blood, No. 8, those caused by a solution of chlorophyll (obtained by macerating green leaves in ether or alcohol), and No. 9, those due to a solution of the vegetable colouring-matter litmus. This last diagram shows clearly also the effect produced upon the spectrum by increasing the quantity of absorbing-material, either by using a stronger solution in the same space, or a greater length of the same solution.

It may be well to conclude the present article with this remark—that a gas or vapour at any given temperature absorbs rays whose wave-lengths correspond to those which it is radiating, and hence that whether the lines in its spectrum are seen bright upon a dark ground, or as dark absorption-lines upon a lighter ground (that of a faint continuous spectrum for example), is a mere question of temperature. It follows from this that the dark absorption lines and bands seen in the spectra of the sun and stars, are due to comparatively cold gases in the atmospheres of those bodies. The precise connection between the bright lines of the spectra of terrestrial elements and the corresponding dark lines in celestial spectra must, however, be reserved for separate treatment.

MENTAL DELUSIONS.

THE variety of diseases which arise from disordered or morbidly sensitive imaginations are innumerable, and develop themselves sometimes in the most astonishing ways. Their most melancholy feature is the fact that they are really incurable under any form of medical treatment, and seldom give way to any moral influences that are brought to bear upon them. Dr. Wadd says:—"Every medical practitioner must have seen or heard of persons fancying themselves made of glass; I once had occasion to visit an *earthenware* patient. A fat gentleman sent for me to treat him for an accident not serious in its nature, but very painful. Lotions, bandages, and plaisters were applied, *secundem artem*, and the case went on most prosperously: but in proportion as he got on surgically, he fell off physically, and instead of being pleased and thankful, he became querulous and morose." At last the patient's valet explained that his master was suffering from hypochondriasis, and fancied himself an earthenware tea-pot! The famous Dr. Watts, shortly before his death, although he was a very little man, firmly believed that no door in his house was large enough for him to pass through. Dr. Millengen mentions the case of a patient who, believing he was a fragile glass vessel, would not sit down for fear of cracking himself; that of another, who was convinced that his skull was perfectly empty; and speaks also of "an intelligent American, holding a high judicial seat in our West Indian colonies, who could not divest himself of the occasional conviction of his being transformed into a turtle." Dr. Walderstein, of Göttingen, recorded in his professional diary the case of a deformed gentleman, of great learning, who could not shake off an absurd belief in all kinds of purely imaginary evils. At one time he felt intensely wretched because he could not sneeze three times in succession, although he was at the same time perfectly conscious of the idea being a ridiculous one. At another time he believed his house was on fire, and felt the scorching heat of the approaching flames; the ringing of a fire-bell adding greatly to his terror and suffering, which were real enough, although he knew the cause would presently be known as an imaginary one. He once dreamt that he had been condemned to be burnt alive, and was in a perfect agony of terror lest his imagination should inflict upon him the actual tortures of that horrible death. Dr. Rush has recorded the case of a man who believed he had a Caffre in his stomach tormenting him, ever since he was at the Cape of Good Hope. Pinel relates a case in which a Frenchman believed he had been guillotined for a crime he had not committed, and that, his innocence having been made manifest, his head, or rather another man's head, had been fastened upon his shoulders, greatly to his annoyance, as he preferred his own. Esquirol mentions some young men who believed they were women, and says one, who had been in the habit of playing female parts on the stage as an amateur actor, would wear no clothes but a woman's. Dr. Conolly speaks of a patient who was convinced that he had been hanged and only partially restored to life by galvanism—his desire was to be fully restored. Jacobi mentions a lunatic confined at Wurtzburg, whose belief—the absurdity of which he was often perfectly aware of—was that another man was alive in his stomach and talked to him. An attempt was made to cure him by pretending to remove a figure from his body after the application of a large blister. He was delighted, and for a while did really appear to be cured; but in a little time the old insane belief returned, and with tears and sobs he told how another man had cruelly taken the other one's place and talked to him in the same way. There is an account extant of a nobleman at the Court of Louis XIV. who, under the impression that he was a dog, would station himself at an open window to bark at the passers-by. Dr. Calmet speaks of some nuns in a German convent who believed that they had all been transferred into the bodies of cats. They wandered restlessly about the building mewing, and sometimes spitting at and scratching each other. Boerhaave relates the case of a man who believed his legs were made of straw, until his servant, while sweeping, struck his shins accidentally with her broomstick.

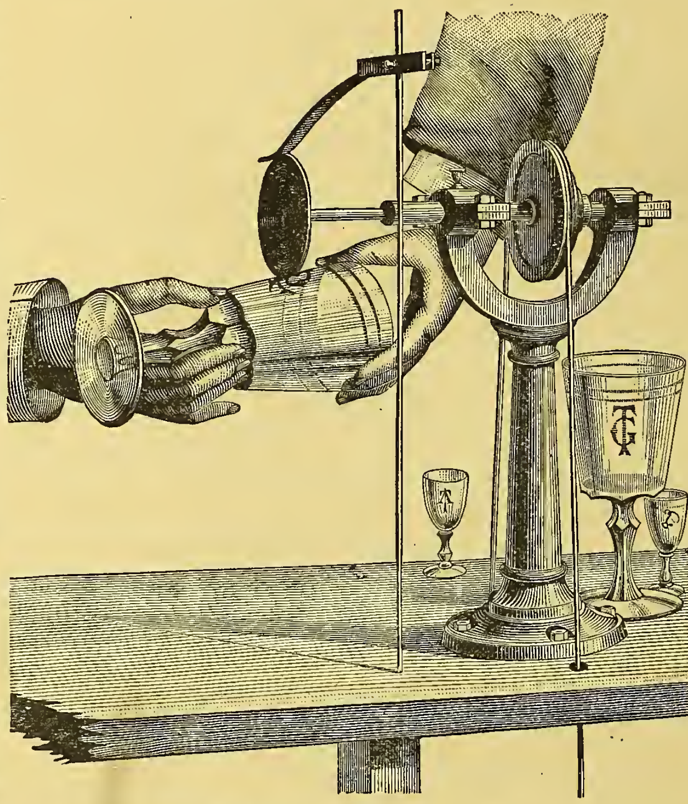
GLASS-ENGRAVING.

THERE are several means adopted for ornamenting glass by operating on portions of its surface so as to give it a frosted appearance. Perhaps the simplest way of doing this is to adopt what may be described as an etching-process.

In etching upon copper and other metals, the artist covers the plate upon which he is about to work with a layer of wax or composition, which he removes in lines, as his etching-needle gradually scratches out the details of the drawing. The metal underneath is by this means exposed, and can be eaten away by the after application of certain acids. In this way the plate is bitten in so as to receive the printing-ink, and to furnish as many impressed copies as desired.

Glass can be etched in very much the same way, and those doorplates of ornamented glass which we now so commonly see in public buildings are produced by the aid of a chemical compound known as hydrofluoric acid. The process can be imitated on a small scale with the greatest ease, as follows:—Take a small glass plate, say four inches square, and cover it with an even coating of wax, by heating it before the fire and rubbing it with the end of a wax candle. Now sketch the design required carefully through the wax, by means of a needle, taking care in drawing each line to expose the glass surface beneath. A tray must now be bent up from a piece of sheet lead, a little smaller than the glass plate. Place in this tray some powdered fluor spar, and pour upon it some common sulphuric acid, so as to form a thin cream. Now place the glass on this tray, waxed side downwards, and support the whole so that a spirit lamp can be placed below. The heat will quickly cause fumes of hydrofluoric acid to attack the glass, and the design will be permanently etched into its surface. The wax can be easily removed with a little turpentine.

When a flat surface has to be dulled all over, it can be better and more evenly done by careful rubbing with another piece of glass liberally supplied with flour emery and water. But where only certain portions of the glass are required to be engraved, the emery must be used in another manner. This is depicted in the illustration, which shows how any one possessing an ordinary foot-lathe can adapt it without much trouble or expense to the beautiful art of glass-engraving. It will be seen that the picture almost explains itself: still it may be necessary to point out its principal features. The mandrel, it will be seen, is replaced by one placed at such an elevation that the article to be engraved, in this case a glass tumbler, can be easily manipulated. Attached by a chuck to the mandrel in the usual manner is a disc of copper well supplied with a paste made of olive oil and emery. Above this disc is seen a piece of metal which rubs against it. This serves a double purpose: in causing the emery to be evenly spread over the circumference of the disc, and in shielding the operator's eyes from any particles which might fly upwards. This shield slides on a rod, so that it may be adjusted at different heights for different-sized discs. As a rule, a set of twelve discs of different diameters will answer for every purpose likely to be required; but if it be desired to cut cameos, or extremely hard stones, a far smaller-sized disc is employed, which is made of steel. A little consideration will show that a smaller disc must be employed for designs which have many sharp turns, than would suffice for a pattern of simpler character.



ENGRAVING DESIGNS ON GLASS.

The speed at which the lathe must be run to execute this kind of work can only be learnt by experience, and the tyro would do best to practice the execution of straight lines and curves of various kinds before he ventures upon more important work.

The apparatus described forms a most interesting adjunct to the ordinary lathe, and by it a mere amateur worker can execute very beautiful designs. Such designs may be traced upon the glass in the first instance by means of Chinese white as a guide to the engraver.

THE BOILING LAKE OF DOMINICA.

As the sailor cruises along the southern shore of the island of Dominica—perhaps the loveliest of all the Antilles—and looks upwards to the forest-covered heights towering some 3,000 feet above him, he notices a thick, white cloud ever hovering over the highest summit, and which, if scattered for a moment by the powerful trade wind, soon collects again and broods as before. Close to the Mulatto Point on the eastern shore, a mountain-torrent enters the sea; its milky colour, its sulphurous smell, and its more than tepid waters intimating that in the highlands above an active *souffrière* exists. Finally, when the wind blows from the south-east a strong smell of sulphur is carried from these heights to Roseau, the capital, about fifteen miles distant, bearing witness to the great extent and present activity of the *souffrière* (sulphur-mine or lake) whence it came.

And yet, until the year 1875, no man could speak definitely of what lay concealed amid those mountain-heights. An old French tradition indeed asserted that somewhere in those hills a boiling lake existed, but it was too indistinct for much reliance to be placed in it. The native Caribs knew nothing, or, at least, would tell nothing, and so for long years the mountains kept their grand secret, until in January, 1875, the first successful ascent in history was made. After three days the two explorers brought back a thrilling account of the difficulties which met them in their search, and of the wondrous scene which awaited and rewarded them when these had been overcome. They spoke of the grandeur and awfulness of the spot which, as far as we can tell, had not until then been gazed on by any civilised human eye.

A second successful ascent was made early in the summer of the same year and a third the following spring. A most interesting and graphic description of the scene was given by a member of the last expedition. After toiling for nearly an entire day through an almost impassable tropical undergrowth, the explorers, as the sun dipped into the western sea, stepped, with hardly a warning, out of the continuous vegetation, right on to the edge of a vertical precipice several hundred feet in height. Below them lay extended the huge gulf of the great *souffrière*, reeking in its every part with thick white sulphur vapours, that rose from its surface and curled up the sides of volcanic rock and hardened ash which surrounded the abyss. Holding on to each other's hands and to the shrubs which grew nearest to the edge, the travellers leaned over as far as they dared, and gazed down into the steaming chasm beneath them. "From innumerable orifices, large and small, some encrusted with bright yellow sulphur, others blood-red with iron oxide, or white with magnesium, there gushed up a mixture of boiling water and steam, amid a constant tumult of noises, hissings, bubblings, and explosions, here more, there less, throughout the whole extent of the gulf. The waters, white, red, and black, rushed out in a strong torrent, scalding hot, and steaming as they went; in many places the vapour-cloud formed a thick impenetrable veil; no plant but an ugly bluish-coloured broad-leaved *clusia* grew for some distance from the blighting fumes."

THE BOILING LAKE OF DOMINICA.

But grand and weird as this scene undoubtedly was, a much grander object awaited their inspection on the following day. Turning to the north-east they made their way, as best they could, across the floor of a second but smaller *souffrière*, a silent burnt-out region of ash and sulphur, surrounded by high bare walls of pumice and volcanic crag. In front of them rose a bare ridge of heaped-up pumice and ash, a dividing wall or partition shutting off the southerly segment of the crater. From behind this, vast columns of steam arose, which to the travellers as they breasted the ridge appeared white as snow against the dazzling blue of the West Indian sky. On the summit of the ridge they stopped suddenly, appalled by the strange and awful sight which lay below them. Fenced in by steep, mostly perpendicular banks, varying from 60 to 100 feet high, cut sharply in the mountain, the waters of a lake about 200 yards long by 100 yards wide rage and roar and toss themselves. "The surface resembles that of a giant seething caldron, covered with rapid steam, through which, when the veil is for a moment blown apart by the mountain breeze, appears a confused mass of troubled waves, crossing and clashing in every direction, a chaos of boiling waters. Towards the centre, where the ebullition is at its fiercest, geyser-like masses are being constantly thrown up to the height of several feet, not on one exact spot, but shifting from side to side, each fresh burst being preceded by a noise like that of a cannon fired off at some great depth below; while lesser jets often make their appearance nearer the sides of the lake."

At a couple of yards from the shore the depth of the lake was found to be sixty feet, but no one has yet been able to test the depth farther out. The temperature of the water where it beats against the cliffs is 185° Fahr., a few feet farther out it is nearly 200° Fahr.

The cliffs surrounding this strange scene are everywhere vertical, but gradually diminish in height towards the southern extremity, where a sharp gate-like rent cuts against the sky, and through which the boiling waters of the lake rush out in a scalding torrent, and carry their heat with them far down the mountain-side, until they enter the sea at Mulatto Point. No vegetation save the *clusia* already mentioned, a dingy moss, and cheerless specimens of *Pitcairnia*, exists within the immediate vicinity of the heated sulphurous vapours, but the hills which form the background to the northward are covered with a dense tropical forest of splendid trees. To the south-east the ground drops rapidly away, height below height, each covered with luxuriant woods. Above is the deep azure of the tropical sky, veiled ever and anon by dense wreaths of steam which rise night and day from the boiling lake; and which are scattered now and then by a stronger breath than usual of the powerful trade wind coming up from the sea. These are, however, soon replaced by others which brood as before over the wild and troubled scene below. We need have little doubt that above that scene a similar steam-cloud has stood as sentinel for ages.

BURIED UNDER THE SNOW.

On the dark wild evening of February 2nd, 1799, a farmer's wife named Elizabeth Woodcock, aged forty-two, was returning from Cambridge, where it had been market-day, to her own house at Impington, on horseback. By about six or seven o'clock she was within half a mile of her home, when a sudden light, probably a meteor, startled both her and the horse. The latter reared and was backing through the deep snow into a ditch, when she suddenly dismounted and tried to lead the animal. But he again reared, and breaking from her, swerved aside into a field. She followed him, losing one of her shoes in the pursuit, and greatly impeded by the weight of the heavy basket on her arm, filled with various articles of domestic consumption. She struggled on through the snow for about a quarter of a mile, keeping the steed in view all the time, but growing rapidly breathless and exhausted. At last she recovered the beast, and was slowly leading him home, when she was overcome by fatigue; her numbed hands could no longer hold the bridle; the heavy basket was perforce abandoned; and she sank down in the snow, saying, "Sinker, you must go home without me; I can't walk any farther."

Unable to move, she sat under a thicket facing the south-west, with the rapidly-falling snow accumulating about her so fast, that when Chesterton church-bell struck eight o'clock it was probably more than two feet above her head. She was in fact buried beneath it. She slept but little during the night, and in the morning discovered a hole in the snow about half a foot in diameter, through which she contrived to thrust a branch of the thicket behind her with her handkerchief fastened to the end of it. In thrusting out her improvised flag of distress, she broke the film of ice which had covered its outer opening, some two feet or more from the inner one. In consequence of this she suffered terribly from the cold, which decreased at a later hour, when the ice re-formed.

There she sat helpless and foodless, unable to move or make her voice heard all through the Sunday and the following night, all through the day following, and again through the night of Monday. She heard the church-bells ring for church and the hours, the passing of carriage-wheels and horses upon the road, the barking of dogs, lowing of cattle, and bleating of sheep. She contrived to get her snuff-box out, and took two pinches, but they afforded her so little gratification that she did not repeat the operation. Day after day, night after night crawled on. One day she overheard some gipsies talking about a donkey they had lost, and the gipsies afterwards remembered talking of their loss close by where she was found. At another time, finding her left hand beginning to swell in consequence of supporting herself with it for a considerable time, she took her two marriage rings and keeper—for she had been married twice—from the fingers, and put them with the little money she had into her snuff-box. She shouted whenever she heard steps passing near, but without once making herself heard.

On Friday, the 8th of the month, a thaw set in; her dress became heavy with wet; her strength had gone so that she could no longer move her limbs; and she began to abandon all hope of being found alive. On Sunday, February 10, Joseph Muncey, a young farmer, passing on his way to Cambridge, at about half-past twelve o'clock, very near where Mrs. Woodcock lay, saw her handkerchief attached to the top of the twigs above the snow, and went up to it. He looked into the aperture from which it projected, heard the sound of hard and difficult breathing within, and saw dimly a woman's form under the snow. He recognised her at once, and knew that she had been missing some days. He ran to a farmer and shepherd standing close by, and brought them back with him, full of incredulous wonder. The shepherd shouted into the aperture:—

"Are you there, Elizabeth Woodcock?"

And she replied in a faint, scarcely audible voice, "Dear John Stittle. I know your voice; for God's sake help me out."

They began hastily to remove the snow, and when John Stittle gave her his broad warm hand she clung to it eagerly, and implored him to stay with her. "I've been here so long, so long," she feebly wailed. "Yes," said he, "ever since Saturday." "Since Saturday week," she replied. I heard the bells for church on two Sundays."

Mr. Muncey had hurried away to fetch the poor soul's husband, and he came quickly with a number of excited neighbours, and the means proper for wrapping her up warmly and taking her home: a horse and chaise, blankets, food, and spirits. Before lifting her up, at her own particular request, they gave her a small piece of biscuit and a little brandy. The stocking of her left leg, being frozen to the ground, came off as they lifted her in their arms, and she swooned. When she recovered they placed her in the vehicle, which quickly conveyed her home.

The husband had been seeking for her in every direction. On the night of her disappearance, after the return of her horse, he and another took out lanterns and explored the neighbourhood, going as far as Cambridge, where they ascertained the hour of her departure. They searched unceasingly for four days, visiting the gipsies, whom they suspected of having robbed and murdered her, and leaving no probability uninvestigated.

When the doctor came, he found the poor woman in a fearful condition: her feet mortified, and all her toes but one had to be removed; in many places the bones were laid completely bare. Death put an end to her sufferings on the 13th of July following.

THE DIAMOND-FIELDS OF SOUTH AFRICA.

THE story of the finding of the first diamond in South Africa has, at first sight, so much more romance about it than reality, that in telling it one is almost tempted to commence in fairy-tale style with—"Once upon a time." But as the tale is no make-believe, but actually true, the time at which the incident occurred must be stated in a somewhat different manner. It will suffice for our purpose to fix it in the year 1866.

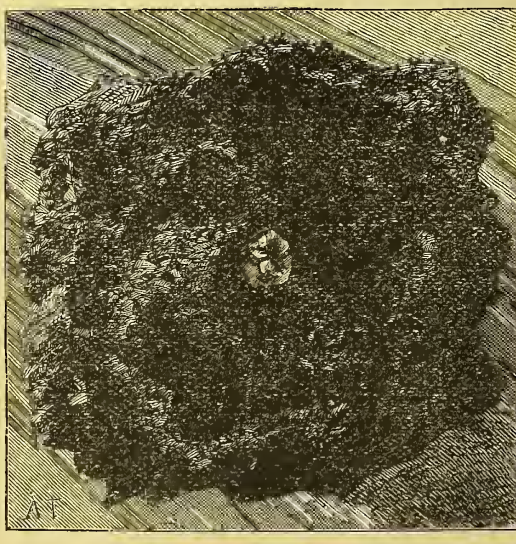
If we look at a modern map of South Africa, we shall see a certain district situated between Cape Colony, The Free State, and Batlapin territory, which is called Griqua-land West. At the period just mentioned a certain Mr. John O'Reilly, who was a hunter and trader, called, in the course of business, upon one of the principal settlers there named Van Niekirk, and accepted his hospitality for the night. One of the Dutchman's little girls happened to be playing with a number of pebbles which she had picked up on the shore of the neighbouring (Vaal) river, and in the course of the evening O'Reilly's attention was attracted by the sparkling appearance of one of these stones. He remarked upon it to his host, and speculated as to what it might be, offering to buy it. But the simple Dutchman could not believe that a pebble picked by a child hap-hazard from the sand could have any possible value, and told his guest to put it in his pocket. O'Reilly accepted the pebble on the understanding that if it proved marketable the Dutchman was to share the proceeds.

The stone travelled with its new owner to Colesberg, and while at the hotel there he showed other travellers what he had discovered, and how with it he could scratch his name on a glass tumbler. He was ridiculed for his pains, and one of the guests laughingly threw the thing out of the window. But O'Reilly recovered his property, and sent it through the post to an expert, who at once pronounced it to be a veritable diamond. Eventually the gem found its way to London, and was valued by Messrs. Hunt and Roskell at £500. Mr. O'Reilly was not long before he began looking about for more diamonds, and many smaller ones rewarded his labours. The news of these discoveries quickly spread, and there was great excitement all through South Africa. Van Niekirk remembered having seen in the possession of a native some time back a stone which he believed to be a finer one than any yet found. But the native also had some idea of the worth of his possession, and would only part with it when Van Niekirk offered him pretty well all his goods. But the speculation proved a successful one, for this beautiful diamond was ultimately sold for more than eleven thousand pounds.

It is noteworthy that these events happened at a time when commercial affairs in South Africa were at an extremely low ebb. Indeed it seemed that the various colonies were almost on the eve of bankruptcy. The many reasons which led to this state of things we need not here enumerate, except to say that a long series of droughts had had much to do with the general depression. Public works had been stopped, throwing hundreds of labourers out of work; farmers were ruined on all sides; and every one was naturally more or less straitened in his means by the crisis which seemed to be imminent.

But the discovery of these diamonds caused the most despondent to rise from their lethargy. At first they expressed doubts as to whether it was all true. They had lately grown so sick of their adopted country, that they could believe nothing to its credit. They thought that, perhaps, some needy landowners had pretended that diamonds were found there, or had actually planted imported stones, in order that their property might rise in value. Their doubts were almost confirmed by an expert, who travelled over the district and asserted his conviction that no diamonds ever were, or could be, obtained from such a soil.

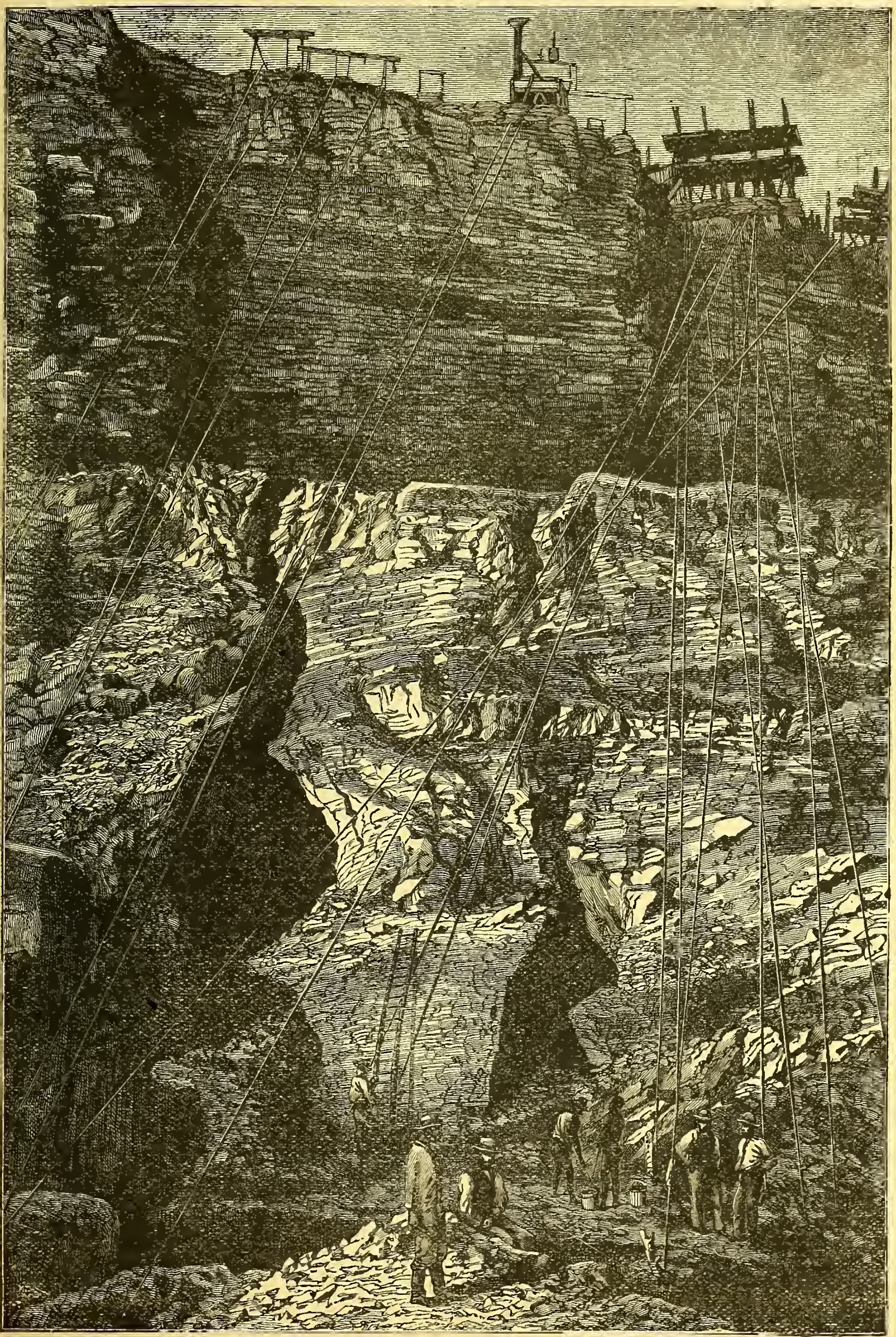
At last a party of explorers in 1869 determined to survey the Vaal river, to find out the truth for themselves. Ridiculed by those who stopped at home, they proceeded on their way, and found the coveted gems. The news of their success soon spread, until hundreds followed their example. Among the first to arrive were some who had had experience of gold-washing in California, and the soil was now searched in the same manner for diamonds. Fortunes were then quickly made. In many cases men who were penniless when they commenced, were at the end of a few months in possession of vast sums of money. Canvas towns, with thousands of inhabitants, sprang up like mushrooms in the favoured localities. Means of transport were soon arranged, shopkeepers and storekeepers became plentiful, and the general prosperity once more revived trade in the South African Colonies. That this was so, and that the prosperity was of a permanent character, may be judged by a glance at the customs returns for Cape Colony. In 1869 the import duties were under two millions sterling. In 1879 they amounted to more than seven millions.



A DIAMOND IN ITS MATRIX

That the valuable diamond is the same in composition as a piece of charcoal is proved by the chemist; for when burnt, the two substances will yield exactly the same products. But the chemist cannot tell us how the carbon has been made to assume this crystalline form. Neither can he nor the geologist tell us how the gems have been placed in the gravel of this African river. From the appearance of the stones they seem to have been water-borne from some far-off region, but that the river always carried them is proved by their presence in terraces of gravel which were deposited ages ago when the water flowed at a much higher level. These terraces are now dry, but being parallel with the river, have been clearly deposited by it in bygone times.

And now let us turn attention to what are called the "dry diggings," where diamonds have been found in abundance many miles from the banks of the Vaal. The discovery of gems in such a locality was also due to accident, and to the sharpness of another Dutchman named Tan Wyk. This man lived in a farmhouse on the road to the Orange River Free State, about twenty-four miles from the river Vaal. The walls of this house had



DIAMOND-MINES AT KIMBERLEY.

been built of mud obtained from a neighbouring pond, and in these walls the Dutchman noticed some little sparkling atoms, which he quickly ascertained to be diamonds.

We may feel quite sure that no time was lost in examining this pond and the soil surrounding it. It was dug up and turned over in every direction, and the gems were found in plenty, the spot being rendered famous for the quantity yielded under the name of "Du Toit's Pan." Another neighbouring farm named Bultfontein also became noted for the presence of diamonds, and eventually the two mines became the property of the London and South African Exploration Company, by whom they were worked with immense profit.

The labour needed in the dry diggings is much easier than in the river-bed, where huge rocks and stones have often to be removed before the diamond-bearing gravel can be placed in the washing-cradle. In the dry diggings the soil is soft, and readily yields to the pick and spade. When dug out it is sifted on to a sorting-table, and the diamonds picked from it. At first these diggings were confined to holes in the ground a few feet in depth, but when it was found that diamonds could be obtained from the soil below, it was pierced, until now some of the diggings are three or four hundred feet deep. It is curious to stand at the edge of one of these artificial craters, and look below on the human ants who are so busy seeking treasure below. Here are representatives from every nation under heaven, and if we were to inquire further we should find that every rank and profession also found examples in the diggings. The most famous of the dry diggings is known as the Kimberley Mine, shown in the illustration. This, like others, was originally divided into different claims, where each man could work on a given space on payment of a certain fee. This mine is about 400 feet in depth, and covers about seven acres of ground. It is now almost entirely worked by companies, whose aërial cables for raising loads of soil to the top of the mine by steam-power are seen crossing and re-crossing each other like the strands of some gigantic spider's web. This result has been brought about by various causes, the chief of which was the necessity for steam machinery as the workings became gradually deeper, which naturally caused those diggers who did not possess the necessary capital to fall back in the race for wealth. The machinery was not only required for digging operations, but in order to pump out the vast quantity of water which flooded the workings when they reached a certain depth.

Although the principal diamond-diggings have been enumerated, there are others of more recent discovery which are fast coming into prominence. One of these is in the Free State, near the town of Fauresmith, and is known as the Jaggersfontien diggings. Although at first the diamonds found here were so few in quantity that the workings were relinquished, operations have since been resumed with astonishing success. The diamonds found have been of splendid quality, and the prices of the claims have run up to a fabulous amount. It may be mentioned, in conclusion, that the finest diamond which South Africa has yet yielded was found by Mr. Porter Rhodes in the Kimberley Mine. It was exhibited a few months ago in London uncut. It had then the appearance of a piece of alum about the size of a chestnut, embedded in earth like the stone shown in our other illustration. It is valued at one hundred thousand pounds.

ANCIENT FLINT IMPLEMENTS.

FROM the earliest historic times in Europe, some knowledge has been possessed of the existence in the surface of the earth of more or less large fragments of flint, and similar stone, shaped into the resemblance of axes, arrow-heads, and other weapons. Mr. Evans, in his work on the "Ancient Stone Implements of Great Britain," has collected together many references to these worked flints in the ancient authors of Greece and Rome; and in the more modern literature of other parts of Europe similar references are frequently to be met with. These variously-shaped flints were, however, regarded until recently, not as weapons of human handiwork, but as objects of natural or supernatural origin, to which, amongst others, the terms "Thunder-bolts," "Elf-arrows," and "*Pierres de Tonnerre*" were applied. That such superstitions should ever have been entertained is the more remarkable when it is remembered to what varied uses flint and stone have been applied by highly civilised peoples. For ages our ancestors were indebted to the flint and steel for their means of obtaining fire, and the flint-locks of fire-arms have only just passed away from amongst us; while Sir William R. Wilde tells us that in some remote parts of Ireland blacksmiths may even at the present day be seen working with a stone hammer, and sometimes upon an anvil of stone. As the knowledge of prehistoric archæology increased, these ancient flint weapons and implements came, however, to be regarded in their true light.

Considering the hard and apparently intractable nature of flint, it may at first appear strange that this should be the material in preference selected by primitive man for the manufacture of his tools. This selection is accounted for partly by the fact that only some peculiarly hard material was adapted to stand the wear and tear to which these tools must of necessity be subjected; but even more by the circumstance that flint (and its allied minerals) is, in fact, from what is termed its conchoidal or shell-like fracture, worked into certain shapes more easily than any similar substance. By striking a block of flint in a certain manner, the acquisition of which, however, requires considerable practice, successive flakes may be detached which are in some cases at once fit for use, either as knives or scrapers, and may at all events be easily fashioned by further chipping and splintering of the edges, into almost any shape desired. That great skill would be necessary, more particularly with the primitive tools at the command of early man, is of course unquestionable ; and it will be seen that this skill was not at once acquired, but probably went on increasing through a great number of years, during which the races of Western Europe were without the use of metal.

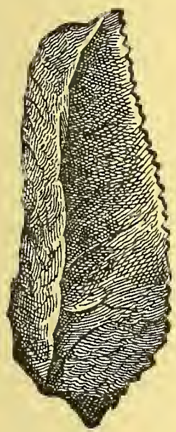


Fig. 1.
SCRAPER OF SINGLE FLINT FLAKE.

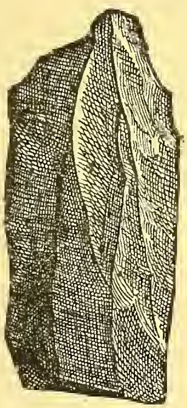


Fig. 2.
CORE FROM WHICH FLAKES WERE CHIPPED.

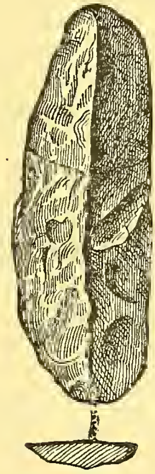


Fig. 3.
KNIFE.

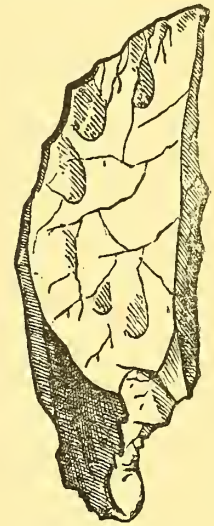


Fig. 4.
TRIMMED SCRAPER.

The period during which man has existed has been divided by Sir John Lubbock and others into the three ages of Stone, Bronze, and Iron. In the last we may ourselves be said to be still living. The Bronze was a pre-Grecian age, during which the use of iron was yet unknown to man, arms of bronze having as early as the time of Augustus (B.C. 30—A.D. 14), been regarded as antiquities ; and the Stone age was an age anterior to that of bronze, during which the use of metal was entirely unknown, and primitive man was dependent for his weapons and implements upon such fragments of stone and flint as his intelligence enabled him to fashion to his uses. The better to explain these terms, however, it should be observed that these three ages do not describe three periods in the *earth's* history, but only three broad stages of progression in the history of human *races*, which may, and in fact do, exist contemporaneously in different parts of the globe. Sir John Lubbock, however, applies the terms strictly to Europe alone, though of opinion that they would apply also to Asia and North Africa. The pre-historic Stone age in Europe he divides into two periods *de convenance:* the first, that of the " Drift " period, characterised by the presence of rough, little-worked implements, he calls the " Palæolithic ; " the second, the later or polished Stone age, characterised by the presence of more artistically and perfectly worked flints, he terms the " Neolithic " period.

The most ancient record of the existence of man upon the earth of which we have, so far, any knowledge is afforded by the discovery of flint implements of the Palæolithic period in what are termed the River Drift gravel-beds of England and France.

The flint implements of the Palæolithic period are distinguishable, as has been said, by their extremely rough workmanship, and, it may be added, by the comparatively limited number of variations in form which occur. Amongst them the most numerous, perhaps, are flakes of various shapes and sizes. While many of these, from their appearance, were doubtless waste pieces struck off from the external surface of the block, in preparing it for the manufacture of more finished implements, yet some even of these appear to have been occasionally used for scraping (Fig. 1). The more finished flakes, struck from a prepared " core " (Fig. 2), have been described as arrow-heads and knives (Fig. 3). Some of these are flat, and some of a polygonal form, the latter being those found in greatest abundance in the River Drift. From the "extreme rarity of any light, sharp-pointed flakes, and the absence of any evidence that those who fashioned them were acquainted with the use of the bow," Mr. Evans considers it improbable that they were used as arrow-heads. That they may have been used occasionally as points to spears and javelins is, however, far from impossible; but their general use was most likely for cutting and scraping, not alone flesh from the bones of wild animals, but also pieces of wood and bone for such purposes as might suggest themselves to these primitive peoples. Certain flakes of this period have been found to which the name of "scraper" has been applied: these have been produced by trimming the end of the flake into a more or less semicircular edge (Fig. 4), and are very similar to some of the "scrapers" still in use amongst the Esquimaux. Another form of this implement, often of large size, appears to have been used for cutting and chopping, as well as for scraping. Pointed implements are of very common occurrence in the Drift deposits. They vary greatly in shape, and are therefore difficult to classify. Some have been called "pear-shaped," but these Mr. Evans has, for obvious reasons, re-named "tongue-shaped" implements, though they are "as varied in their form as the tongues of the different members of the higher orders of the animal creation. A characteristic feature of these tongue-shaped implements (Fig. 5) is the thickened and frequently untrimmed form of the base, from which it is believed that they were held in the hand by this part, though possibly they may occasionally have served as spear or javelin heads. Some seem to have been used for chopping, others for boring, others, again, for digging in the ground, and perhaps some were employed for cutting fishing-holes in the ice. Another form of pointed, though not tongue-shaped, implement is found with only one sharpened edge, the other edge being left thick, and frequently unworked. These implements are supposed to have served as knives. Lastly, amongst these primitive Drift implements, certain "sharp-rimmed" objects occur in very large numbers. These are of all shapes and sizes, some being almost circular, others heart-shaped, lozenge-shaped, more or less triangular, or almond-shaped. Though possibly some of these, particularly those of almond-shape, may have been used as heads for javelins, or even arrows, there can be little doubt that the majority were employed for cutting and scraping; nor does it appear to be generally believed that more than two divisions of these Drift implements can be made—the "pointed implements for piercing, digging, and boring, and sharp-edged implements for cutting or scraping." Their edges are never found to have been sharpened by grinding, which was an art of altogether later invention.

It is interesting to observe the very wide-spread localities from which these primitive implements have been obtained. While England and France may still be regarded as their headquarters, yet almost identical specimens have also been found in Italy, Greece, Spain, and other parts of Europe, in Egypt and even in Southern India; and though the latter were of quartzite instead of flint, the form exactly corresponded with that of some of the Drift specimens of Western Europe.

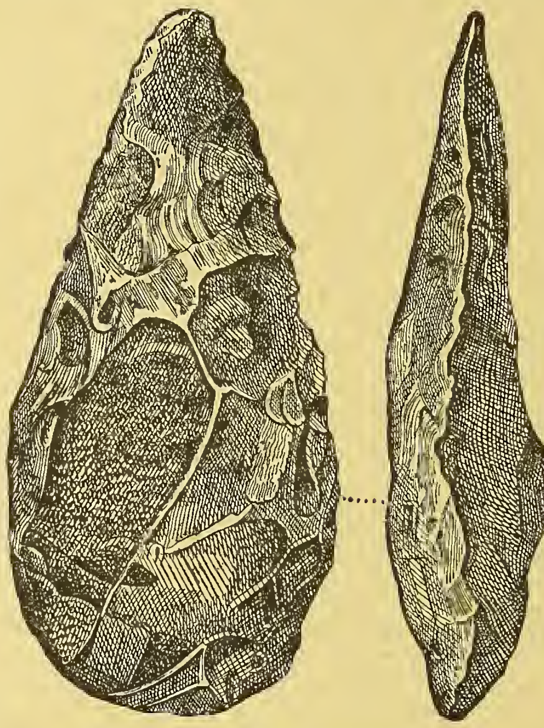


Fig. 5.—TONGUE-SHAPED IMPLEMENTS.

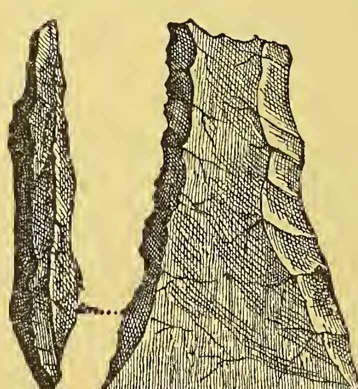


Fig. 6.—CELT WITH GROUND EDGE.

Of the forms of implements of the Neolithic or Later Stone period it is possible only to give the briefest account ; for objects of this age are so numerous, and are distributed so widely over the surface of the earth, that to enumerate even a tithe of the varied shapes met with would fill a volume. Some of these have been found in ancient tumuli, some buried with the remains of ancient lake-dwellings in Switzerland and elsewhere, and some, again, in those huge piles of shells and refuse found chiefly by the sea-shores of Scandinavia and of Oregon, to which the Danish name of "Kjokken-mödding," or kitchen middens, has been applied. The greater number are, however, found in more or less isolated positions scattered about beneath the surface of the alluvial deposits, while not a few similar implements are still in use amongst various savage tribes throughout both the Old and New Worlds. Though it can scarcely be said that the transition from the Palæolithic to the Neolithic flint implements can be distinctly marked in Europe, yet some of the flints of the latter period are unquestionably of rougher and more primitive workmanship, and indicate a greater antiquity than others. Thus some of the so-called celts (Latin, *celtis*, a chisel), or axes, are of exceedingly coarse form, and present surfaces roughly chipped, without any indication of grinding or polishing, except on the edge (Fig. 6). Others are still more highly finished, until at last specimens are found the whole surface of which has been ground smooth, so that no indication remains of the chipping process by which the original form was at first obtained. These celts must have served as axes, hatchets, and adzes, either for war, the chase, or for domestic purposes, and were no doubt generally fixed in a wooden or stag's-horn handle, of which several have been discovered in a more or less perfect condition, sometimes with the stone celt still *in situ* (Figs. 7 and 8). Implements almost identical in form are still in use amongst many uncivilised races. Besides these we find, though less frequently, axes perforated for the reception of a wooden handle, possessing sometimes one and sometimes two cutting-ends (Fig. 9).

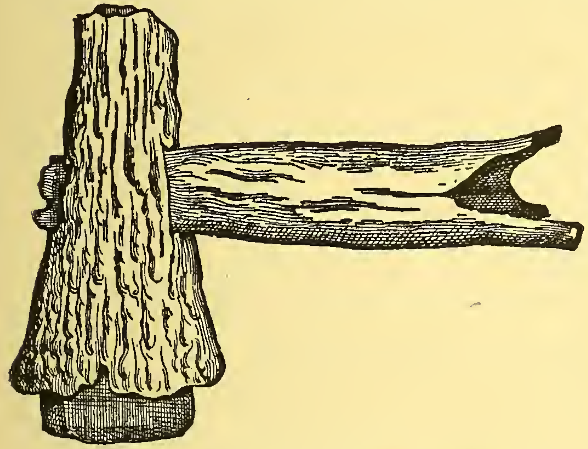


Fig. 7—HATCHET IN HANDLE OF STAG-HORN AND WOOD.

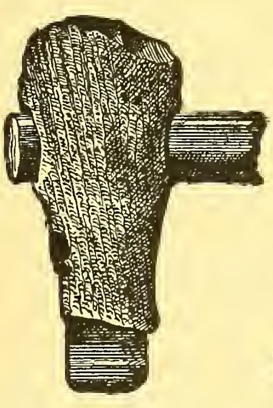


Fig. 8.—HANDLED HATCHET.

Fig. 9.—POLISHED AXE.

Flint-flakes in this, as in the former age, served as knives, and many very beautiful specimens are met with. They frequently resemble very closely those cutting-implements still used by the savages of America and Australia, and were doubtless used for the same purposes, amongst which *shaving* is to be included. They were also formed into daggers, sometimes of most artistic form and workmanship (Fig. 10), and are occasionally found with serrated edges which served probably for sawing small articles of wood, horn, and bone (Fig. 11). The primitive "scrapers" also still occur in the European Neolithic age, and differ little except in finish from those earlier ones which have been already described. Some could, however, hardly be distinguished by their form from those similar implements still used by the Exquimaux for knives. They were probably often used, together with pyrites, for obtaining fire, and to some forms is therefore applied the term "strike-a-light."

While it is doubtful whether the early inhabitants of Europe during the Palæolithic period were acquainted with the use of bows and arrows, there can be no doubt that those of the later Neolithic period made large use of these weapons. Not only have fragments even of wooden bows been discovered in the lake-dwellings and shell-mounds, but innumerable arrow-heads of flint have also been found, sometimes but little more finished than mere flakes, at others most carefully and sometimes elegantly worked into various forms. While from their size there can be no doubt that some of these heads were for arrows, others were probably javelin-heads; all were apparently fixed to the shaft by twine or fibre of some kind, in a manner similar to that now used amongst savages. Other implements met with in the European Neolithic period which are not known to occur in the earlier Palæolithic age are stone hammers and hammer-stones, sling-stones, and grinding-stones, the last of which were doubtless used in working the more finished polished implements. Certain implements having somewhat the shape of sharks' teeth, which are also frequently found, have been described as "borers," and were perhaps used for drilling holes in wood or bone, or possibly even in stone.

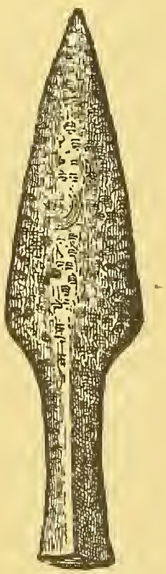


Fig. 10.—FLINT DAGGER.

Fig. 11.—FLINT SAW.

Thus, though containing but an imperfect record, these ancient flint implements nevertheless give us no little insight into the manners of our most remote ancestors in Europe, and enable us to conceive with some approach towards accuracy what must have been the life of the inhabitants of Western Europe many centuries before even the first glimmer of authentic history. However rude these early tools may have been, we see that they are still essentially *tools.* They show man standing even then as clearly above the brutes as he does to-day, by that very fact. The animal constructs habitations, but never a tool: it can only make the best of its natural conditions, which it often does in a truly wonderful way. But man, from the very first, however primitive, we find bending what Nature offers him to his own purposes, and so no longer subject to her, but raising himself above the conditions which surround him.

SOME WONDERS OF VISION.

WHEN a pigeon has been taken fifty miles away, in a basket, without any chance of seeing the way it has been led, and has then been thrown up to find its way home as best it could, it has been a matter of no small surprise how soon the bird has reached its cote, showing clearly that it has not hesitated long as to which way it should take.

A mountain-top has been seen ninety miles away when the atmosphere has been clear, which means that if the observer had been stationed on the mountain-top, with an equally clear atmosphere all around him, he would have been able to command a view of a vast circle of land and water with a diameter of 180 miles, or, roughly speaking, a range of horizon of over 560 miles. Even in our not very clear air Glaisher has seen the Dover cliffs when in a balloon a mile above London; and if he had been in the habit of making daily ascents like a bird, it is certain that he would have been able to familiarise himself with the peculiarities of stream and river, wood and forest, hamlet and city, which presented themselves within the circle of seventy miles' radius which he could command with a sweep of his eyes. It will be readily seen, therefore, that if a man with such a knowledge were led away blindfolded to some place fifty miles off, and then sent up in a balloon, he would instantly recognise the landmarks, and if the air-currents favoured him he could make straight for home. A bird like the pigeon is more favourably situated still, for if it be sent up even a hundred miles from home, it has only to fly round in a great circle until it recognises some distant peculiarity of hill or river, then its course is determined on at once.

But although here strength of vision evidently depends on the sensitiveness of the retinæ, elevation of the observer, and clearness of the atmosphere, it is a wonderful thing indeed that the images of things in a landscape—meadow and river, hill and valley, &c.—are all thrown on to the cup-like expanse of retina (*r*) in the eye (Fig. 1), about an inch in diameter, with such faithfulness that one can make out particulars which are truly surprising. There is the church-spire yonder, three miles away. It is 300 feet high, but it covers on the human retina only just about 1–100th of an inch. As the church is approached, the image on the retina grows bigger, so that at a distance of one mile the length of the image of the spire is now about the 1–33rd of an inch. Hence, if one were carried silently towards it without any sign of motion this increase of the size of images on the retina would be a sure sign that the objects they represented were being approached.

There is a limit, however, to the sensitiveness of the retina. A few miles away the telegraph-lines are invisible, showing that a wire so thin cannot be discerned at a great distance. The breadth of so thread-like an image is not sufficient to cover one of the constituents of the retina known as cones, and cannot excite the sensation of sight unless the distant wire is itself a source of light. Then if the wire be a *bright* source of light, like a white-hot thread of platinum, it appears to be very much thicker than it really is, being an example of what is known as *irradiation.*

Inside the eye there is a lens, *c* (Fig. 1), wonderfully clear and ice-like. It is known as the crystalline lens. This lens projects the picture of the landscape on to the retina *upside down.* An idea of why it is so may be obtained by experiment. Some evening take a spectacle-glass, one which is thicker in the centre than at the sides, and hold it in front of a sheet of white paper, say a few inches away, while the gas or candle light is shining in the middle of the room. The image of the flame on the paper is upside down. It is the same in

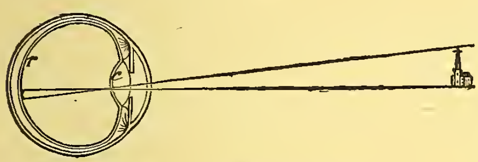


Fig. 1.—IMAGE IN THE EYE.

the eye; the crystalline lens acts like the spectacle-glass, and the retina receives the images like the sheet of white paper. It appears somewhat extraordinary at first sight that we should see things upright so long as their images are inverted on the retina. But in itself the retina has no means of telling one which of its parts are at the top and which at the bottom, and all its indications have from our earliest years been coupled with other sensations. Thus, let us suppose you have reached the spire we were speaking of, in measuring it with your eyes you slowly lift your head up, and here, in obtaining the idea of top and bottom, the muscular sensation arising from the action of the muscles of the neck has taken an important part. From experiences like this and others we have come to judge of the position of things by putting them down at one end of the rays which come from the external body, and then enter the eye, and pass through its centre to the retina.

The peculiar phenomenon of *phosphenes* presents an exception sometimes to the latter statement. We will first describe how a *phosphene* may be seen. Shut, say the left eye, and with a finger applied between it and the nose, press the eyeball and work the finger up and down. There then appears a small circle of light called a *phosphene*, which in some cases is of a dark green, or blue in the centre, with a whitish border. Sir Isaac Newton has spoken of it as "a circle of colours like those in the feather of a peacock's tail." Here the sensation of light is produced by a mechanical agitation of the retina, and many people refer the phenomenon to the neighbourhood of the retina, and even see the *phosphene* moving up and down in a direction contrary to that of the moving finger. It would appear, however, that there are others who can by an effort of imagination transport the images of these *phosphenes* into space.

There are other cases of pictures formed within the eye, unlike ordinary images that are referred without any trouble to the outside of the eye. Perhaps the most remarkable example is that of Purkinje's figures. Go into a dark room with a candle. Close the left eye, and work the flame of the candle upwards and downwards close to and on the right side of the open eye, while you gaze into the gloom of some dark corner. There is clearly seen, as if outside the body and somewhere in front of it, a complicated branching pattern, which is really caused by the shadows of the branching vessels in the fore part of the retina falling on its sensitive hind part.

CURIOSITIES OF PATENT-LAW.

A MOST extraordinary decision was given by Lord Ellenborough in 1817, in the case of Metcalf's patent for a tapered hair or head brush. The invention was a very ingenious one, which has since been generally adopted; but rival brush-makers having applied for a repeat of the patent, Lord Ellenborough decided as follows: "Tapering means gradually converging to a point; according to the specification, the bristles would be of an unequal length, but there could be no tapering. If that word be used in its general sense the description is defective; if the term has by the usage of trade a different meaning, it may be received in its perverted sense; but I cannot hold out any prospect that the difficulty arising from the *grammatical construction* (!!) can be removed." The verdict was accordingly given against the patentee, and a motion made next term for a new trial was refused. The brush was allowed to be a perfectly new invention, and was really and literally a tapering brush, yet the case was decided upon a grammatical quibble.

In 1778, when an action for infringing Sir Richard Arkwright's patent for spinning machinery was tried in the King's Bench, the imperfect wording of the specification was urged, and because certain workmen declared they *could not* make the machine from such a description, a verdict was given *against* the patentee. But in 1785, a verdict was given in another trial *for* the patentee, on the ground that witnesses *had* made the machine from instructions given in the specification.

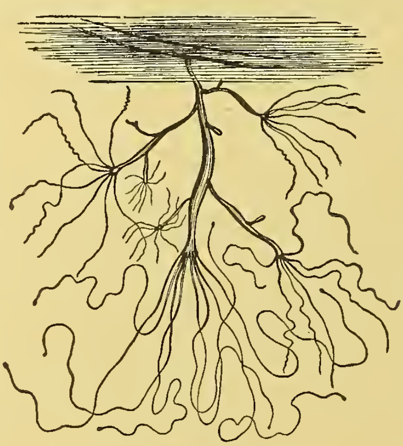
STINGING ANIMALS.

THERE are comparatively few animal forms which do not possess some means or other whereby they can readily escape from their enemies, or whereby they can defy the attacks of their natural opponents. Nature, in other words, rarely, if ever, leaves her creatures absolutely defenceless. Some of the most interesting discoveries of late years in natural history have been made in the direction of showing that very frequently a defenceless animal will derive protection from the resemblance it develops to another and well-protected form, or from the accurate fashion in which it mimics its surroundings. For example, a sole or flounder so closely approximates the colour of the uppermost side of its body to the line of the sand on which it lies, that until the fish begins to move it can hardly be detected by the most acute vision. Every one knows how the speckled hue of the partridge and grouse mimic the heather amidst which they live; and the woodcock was declared of old to be recognisable to the sportsman only by its flashing eye—so perfectly do its surroundings conceal it.

In such ways, then, does Mother Nature often protect her children. But the mimicry to which we have alluded is by no means the only protective means seen in the animal world. On the contrary, the list of animal defences waxes very large when we take a wide survey of the fields of animal life. Animal armouries almost without end rise before our view when, led by the zoologist, we make the "grand tour" of the world of animal life, Defensive and offensive weapons, also, are very common in well-nigh every grade of animals, from the lowest to the highest; and, in truth, it is not always the highest tribes of animals that possess the most complex of weapons. We also notice that the animal armouries are each contrived so as specially to affect the particular organisms with which their possessors naturally come in contact; and this relation between the means of assault and the assaulted forms one of the most interesting features of the topic under discussion.

The best examples of animal weapons in lower life are found in the jelly-fishes, sea-anemones, corals, and like animals. In these beings we find the body to be plentifully provided with curious "stinging cells," named "thread-cells." Each of these cells consists essentially of a minute sac, or bag, filled well-nigh to bursting with a fluid, and possessing, coiled up within this fluid, a thread-like filament. It is from the presence of this thread that the cell derives its name. The sac existing, as just remarked, in a state of extreme tension, the slightest pressure, such as may be exerted by contact with a foreign body, is sufficient to rupture the sac. The fluid and the contained thread together escape; and as the thread can in this way be projected to a distance from the sac, it may be regarded in the light of a dart, whilst the fluid itself is undoubtedly of an irritating and poisonous nature.

The nature of the thread-cells is well seen when we study under the microscope the life of some of the animals which possess them. The common *hydra*, or "fresh-water polype" of our pools, is furnished with a very perfect armature of these cells. When a water-flea or worm approaches the hydra, it is grasped by the tentacles of the latter. At first the prey struggles violently against its fate, but it soon ceases its struggles, and becomes apparently paralysed. The explanation of the cessation of movement is by no means a difficult matter, when we discover that the hydra's tentacles literally bristle with thread-cells. When one of these tentacles, therefore, touches the body of the prey, it liberates its hundreds of thread-cells, each possessing its dart and its poison-fluid; so that we perceive in such a mechanism a powerful means for ensuring the paralysis and death of prey which otherwise might tend to escape the grasp of the tentacles alone.



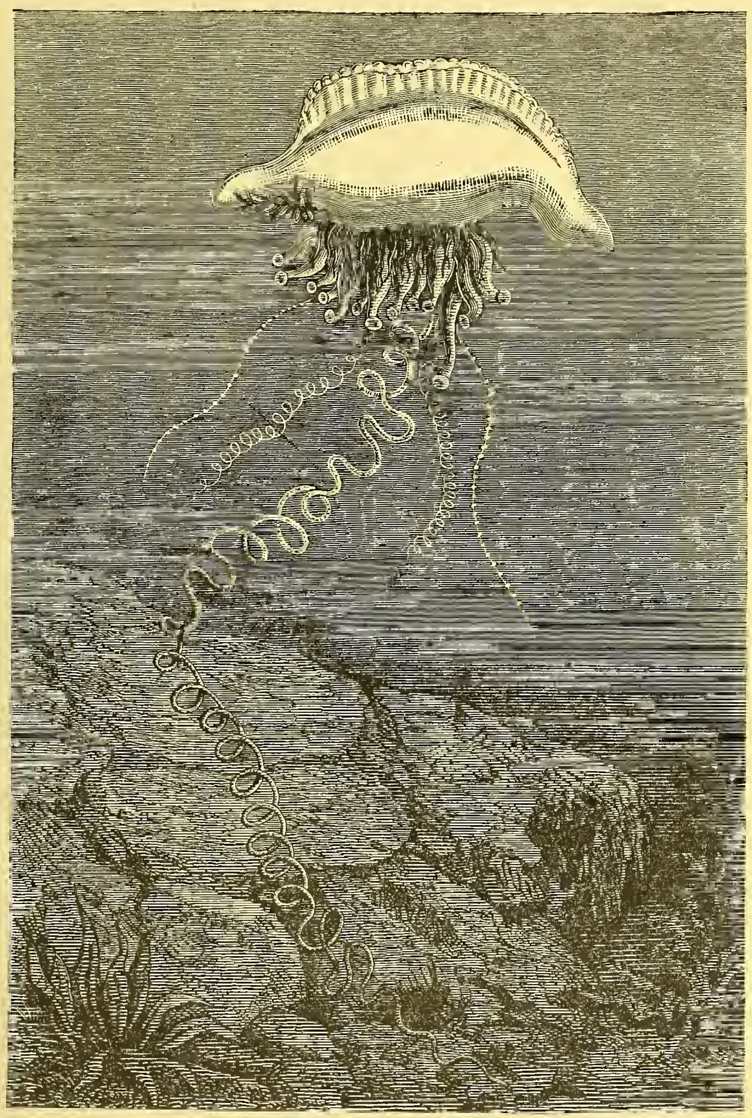
THE HYDRA.

The thread-cells of most of the animals which possess them do not appear to possess any decided action on the bodies of man and higher animals generally. But, at the same time, there are one or two notable exceptions to this rule. Every bather has learned, by the experience either of others or of himself, to avoid the jelly-fishes as decidedly unpleasant marine neighbours. These animals have obtained an evil repute on account of their stinging powers; and there is no doubt that the tropical species sting very severely, and that certain British kinds also possess virulent properties as regards the human skin. To thread-cells of powerful nature the jelly-fishes owe their offensive peculiarities.

Long ago, Aristotle called these animals *Acalephæ*, or "nettle-stingers," from their well-known powers of attack. The poet Crabbe speaks of—

> "Those living jellies which the flesh inflame,
> Fierce as a nettle, and from that its name;
> Some in huge masses, some that you may bring
> In the small compass of a lady's ring."

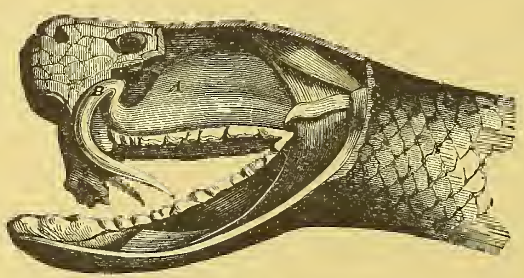
Professor Edward Forbes, long ago, gave a glowing word-picture of the attack of the jelly-fish when he said of the species that "it is a most formidable creature, and the terror of tender-skinned bathers. With its broad, tawny, festooned, and scalloped disc, often a full foot, or even more, across, it flaps its way through the yielding waters, and drags after it a long train of riband-like arms and seemingly interminable tails, marking its course when the body is far away from us. Once tangled in its trailing 'hair,' the unfortunate who has recklessly ventured across the graceful monster's path too soon writhes in prickly torture. Every struggle but binds the poisonous threads more firmly round his body, and then there is no escape; for when the winder of the fatal net finds his course impeded by the terrified human wrestling in its coils, he, seeking no combat with the mightier biped, casts loose his envenomed arms and swims away. The amputated weapons, severed from the parent body, wreak vengeance on the cause of their destruction, and sting as fiercely as if their original proprietor itself gave the word of attack."



PORTUGUESE MAN-OF-WAR.

But a tropical form, the *Physalia*, or "Portuguese man-of-war" of sailors, is even more terrible in its offensive phases than the jelly-fish. This beautiful organism consists of a bladder-like "float," on the under surface of which are the numerous little beings that compose the living colony. Contact with this creature is of a highly injurious nature. One observer described the effects of its thread-cells on his body, as if he had plunged his arm up to the shoulder in boiling water. Another speaks of the pain as so intense that he nearly fainted. Mr. Bennett, a well-known naturalist, tells us that not merely was the pain he experienced after contact with the Physalia very acute, but a great deal of irritation prevailed through his system generally. Fishes coming in contact with the offensive tentacles of the "man-of-war" are paralysed, and it is said that a Physalia the size of a walnut will readily kill a fish the size of a herring.

In animals of higher grade than the jelly-fishes and their neighbours, we find many excellent examples of "stinging" and offensive apparatus. The centipede class presents us with such illustrations, for we find these familiar animals in possession of a poison-apparatus, in the form of a pair of the jaw-feet, which constitute "fangs," and which communicate with a poison-gland. In all stinging animals of higher grade, we find the provision for attack to be of a similar nature. There is firstly the "fang," or weapon, and this may be a tooth, as in serpents; part of a jaw, as in the centipedes and spiders; or a modified tail-appendage, as in bees and scorpions. Then, secondly, we note that this fang communicates with an internal poison-gland, in which the poison is manufactured, and from which it is expelled, when required for use, through the fang, and into the body of the attacked animal. The stinging-apparatus in the bee and wasp is of an extremely interesting nature. The "sting" consists, in reality, of the same organ which in other insects is called the *ovipositor*, and which is used, as its name implies, in depositing the eggs. It consists essentially of a sharp-pointed, lancet-like tube, carefully protected by adjacent parts, and communicating with the poison - gland within the body. Special muscles are devoted to the movements of the sting, and to the compression of the poison-sac. In the scorpion, as every one knows, the sting is placed at the tip of the tail, and is a hooked, sharp-pointed "fang." A curious feature has been noted to occur in the scorpions, and one which may be termed a tendency of a suicidal nature; for when irritated, these animals have been seen to plunge their sting into their own bodies, and thus to cause death.



HEAD AND FANGS OF A SERPENT.

It may be said, however, that the perfection of a stinging-apparatus is found, without doubt, in the serpent-tribes. In a poisonous snake we discover two hollow, or grooved, teeth (B), often capable of being erected or lowered in the mouth, and springing from the upper jaw. These teeth are in direct communication with the poison-glands of the snake (A), which, by the way, are simply the animal's *salivary glands* modified and altered for a destructive function. Hence, when a snake "stings," the fangs make the wound, and at that moment the poison is squirted into the wound by the forcible and muscular compression of the poison-glands. As is well known, the poison of a healthy and fresh snake belonging to such a species as the cobra of India, or the death adder, or rattlesnake tribe, is very fatal, and rapid in its action. Serpent-poison seems to kill by rendering the reception of oxygen by the blood impossible. That we require a constant supply of oxygen, obtained from the atmosphere, is, of course, well known. Any cause, therefore, which prevents the free circulation of oxygen through the body must, of necessity, involve a fatal issue.

Very recently there have come to hand the details of a new stinging animal, in the shape of a poisonous lizard (*Heloderma suspectum*) from Arizona (U.S.). A specimen of this new and interesting scientific curiosity was sent to the London Zoological Gardens in the year 1882. Until recently, no poisonous *lizard* was known; but there is now no doubt that the Heloderm tribe is invested, like the snakes, with grave powers of inflicting evil on other animals. These lizards have not only grooved teeth communicating with poison-glands, but all the teeth are thus rendered "stings," and the "glands," like those of the serpents, are modified salivary glands. The Heloderm's bite is certainly fatal to small quadrupeds and birds; and amongst the natives of Mexico it has long held an evil reputation as dangerous to man. One American naturalist relates that he was bitten in the hand by one of these lizards, and that in a few moments he suffered from severe shooting pains, which ran up his arm, and from swelling of the limb. For several hours the pain was very severe, but gradually lessened in intensity. From this recital there would appear to be good cause to fear that even if the Heloderm lizards do not possess poison of sufficient virulence to cause the death of man, they at least possess a power of causing him severe pain and annoyance for many hours.

The fishes, as a class, are singularly destitute of examples of stinging animals; but there exist one or two cases in which means of defence of a very curious nature are found within the limits of the group. The "sting-rays" are skates in which the tail is armed with strong spines, which are capable of inflicting a very nasty wound, and which, although not of a poisonous nature, nevertheless seem to possess very irritating properties. In the "weaver" fishes, the spines on the back and gill-covers are similarly very sharp and offensive, and the spines are further covered and charged with a glairy mucous fluid, thus presenting a likeness to the serpent's apparatus. In one fish (*Synanceia*) of the Indian Ocean, there exist regular poison-glands, and spines, or fangs, placed on the back of the animal. The native fishermen avoid these fishes, as a fatal issue of their sting is not unknown. But in another fish group (*Thalassophryne*), a still better-developed stinging-apparatus exists. The two back "spines" and the gill-cover spines constitute the weapons of attack. Each spine is hollow, like the fang of a snake, and each has a poison-gland at its base. These fishes inhabit the Central American coasts, and their "bite" is regarded as highly dangerous.

THE SENSE OF SMELL.

JAMES MITCHEL, who died in or near 1833, in the county of Nairn in Scotland, and was born blind, on November 11th, 1795, recognised different persons by smelling. The famous Mr. Boyle mentions a blind man at Utrecht who could distinguish different metals by the different odours; and Martial records the case of a person named Mamurra, who could tell by smelling whether copper was true Corinthian or not. Indian travellers have recorded that certain natives who habitually abstain from animal food have a sense of smelling which is so exquisitely delicate that they can tell from which well a vessel of water has been obtained. It has been related that by smell alone the negroes of the Antilles will detect the footsteps of a Frenchman from those of a negro. Marce Marci has left an account of a monk at Prague who could tell by smelling anything given to him who had last handled it. The guides who accompany travellers in the route from Aleppo to Babylon will tell by smelling the desert sand how near they are to the latter place.

Nathaniel Wanley, in his "Wonders of the Little World," a famous old book, gives a particularly full account of a man, called John of Liege, who, when a boy, flying in terror of soldiers in a time of war, passed many years alone in the depths of the forest of Ardenne, where he lived upon roots and wild fruits, the presence of which he could at last detect from a great distance by the smell alone. In the same way he detected the presence of men long before they came in sight. He was caught, and a woman took charge of him, of whom he grew very fond, and would follow her scent as readily and with as much certainty as a dog could. Returning to the manner and customs of civilisation, this extraordinary power of smelling deserted him.

The same authority mentions as within his own personal observation the case of a man who was very temperate and fed sparingly, and who could detect by smell many things which were perfectly without odour to others.

MAGNETO-ELECTRIC MACHINES.

IN a former article we have described Faraday's great discovery of electric induction, by which he proved that a current flowing in a wire aroused or induced another current in a neighbouring conductor. The same busy experimenter made another greater discovery in pointing out an entirely new method of evoking electricity. The importance of this latter discovery will be understood when we assert that the recent excitement concerning electric illumination, as well as the marvellous applications of electricity to tramways, and to the transmission of power from place to place, owe their origin to two apparently simple experiments on Faraday's lecture-table (Fig. 1). A hollow coil of wire has its ends (*f f*) connected

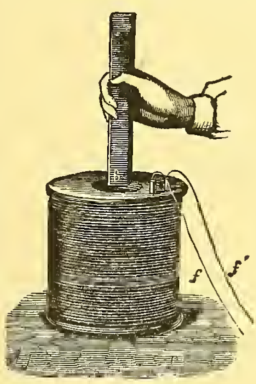


Fig. 1.—FARADAY'S EXPERIMENT.

with a galvanometer. Placing a magnetised steel bar (A B) within this coil, Faraday noticed that the galvanometer needle was deflected, showing most conclusively that the simple approach of the magnet was sufficient to generate an electric current in the coil. Upon withdrawing the magnet, a current is again rendered evident by the movement of the needle, but in the reverse direction. Again, if the coil enclose a bar of soft iron, the magnetism induced in such a core by the approach to or recession from a magnet will cause similar results. These two experiments comprise Faraday's marvellous discovery of magneto-electric induction.

It is not surprising that such a discovery should arouse great attention from all classes of society. The scientific world, of course, took absorbing interest in it for its own sake, as a wonderful contribution to knowledge; but there were others who looked upon it rather in a commercial aspect, and who saw that if the costly battery hitherto in use could be superseded by the magnet, the strange power called electricity would no longer be limited in its applications, but could possibly be made of immense service in many fields of labour. We know how this dream has been realised to a marvellous extent, although it is the opinion of most of us that electrical science is even now in its infancy.

Pixii's machine was the first attempt to utilise Faraday's discovery. It consisted of an inverted horse-shoe magnet, which, by multiplying gear and a handle, was made to revolve rapidly. Above the poles of this magnet were placed two coils of wire, so that as the magnetic poles alternately approached to and receded from the coils, currents were generated in them.

From what has been already said relative to the behaviour of Faraday's coil when a magnet was approached to or removed from it, it will be understood that the currents obtained from such a machine as that of Pixii must be in *alternate* directions. For electric lighting purposes this would be no objection, for a slight modification of the lamp or regulator would meet the difficulty. But for electro-chemical purposes, such as silver-plating, the current must maintain one direction, and be similar in that respect to the current furnished by a voltaic battery. To correct the continual reversal of the current given by this and other early machines, a simple arrangement called a commutator was attached. It consisted of a little cylinder formed of some non-conductor, and having upon it two half-cylinders of metal —metallic springs, or friction-pieces resting alternately against these half-cylinders turned the alternate currents into one direction. The commutator, marked *f*, will be observed in Fig. 2, which represents the next improvement in Magneto-Electric Machines which is worthy of notice. This machine, contrived by Clarke, will at once be recognised as a great improvement upon that of Pixii, although in principle it is identical. Here we have a bundle of horse-shoe magnets (B A) not in movement but fixed rigidly on a wooden upright. Clarke saw with the eye of a clever mechanic that it would be

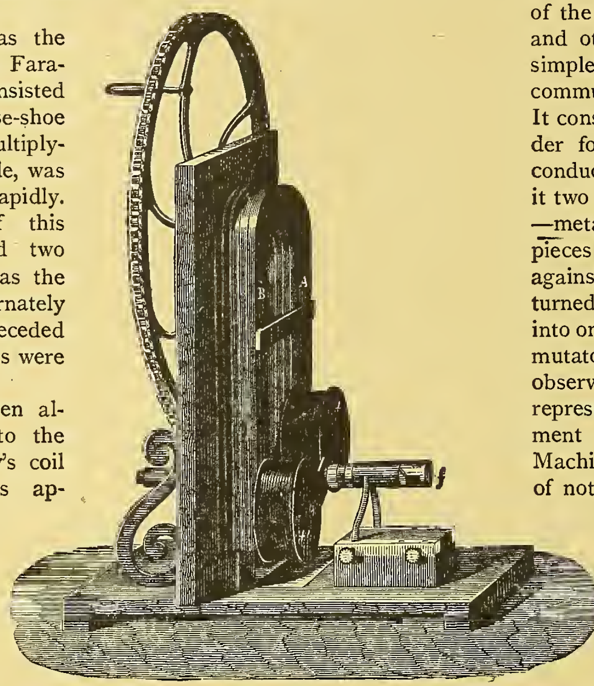


Fig. 2.—CLARKE'S MACHINE.

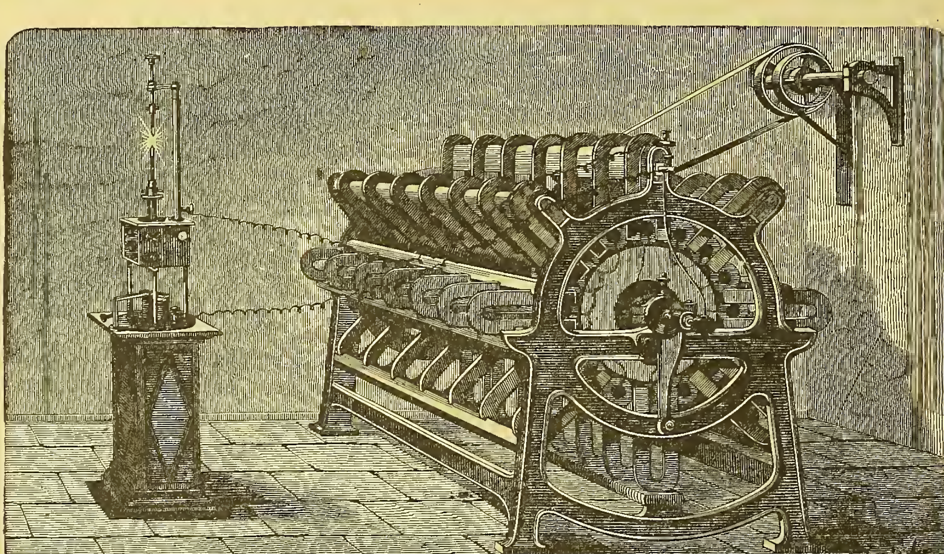


Fig. 3.—THE "ALLIANCE," THE FIRST ELECTRIC-LIGHT MACHINE.

much more convenient and economical of power to rotate the coils *t t* than the heavy magnet, as did his predecessor. So by means of a fly-wheel and a handle—shown at the back of the figure—he was enabled to rotate these coils at a great speed in front of the poles of the magnet, and by the attached commutator to turn the alternate current so obtained into a current having one constant direction. Such a magnetic machine is now commonly employed for medical purposes, and can be seen in most chemists' shops. A peep inside its containing-box will show the horse-shoe magnet at the side, and the double coil, which can be rotated by the handle attached. These experimental machines were soon followed by others of a larger and more powerful kind. It is impossible to notice all these in detail, but the most practical of them was that invented by M. Nollet, afterwards known as the Alliance Machine (see Fig. 3). This machine was first constructed in the endeavour to carry out one of those chimerical ideas which now and again come before the public, and are speedily forgotten. The idea in this case was to decompose water into its constituent gases—hydrogen and oxygen—which gases were to be used for heating and lighting purposes. Much capital was sunk in the experiments by which the promoters of the scheme hoped to attain their purpose, before they found out that gas so produced cost a fabulous sum. But the Alliance Machine was born of these experiments, and, with improvements, was adopted for the electric illumination of several French lighthouses. The same machine was also introduced to light the two beacons which stand on the South Foreland, just above Dover. A glance at the illustration will explain the general scheme of this machine. A cast-iron frame supports eight series of steel magnets in parallel rows, so arranged that their poles point in one direction. In this focus, so to speak, revolves a horizontal iron axis furnished with bobbins of wire. From what has gone before it will be readily understood how these coils of wire must generate an electric current as they are rapidly carried past the magnetic poles. It need hardly be pointed out that this immense machine requires the aid of steam to put it into motion. Indeed, a visitor to the South Foreland Lighthouse who is ignorant of the history of these machines is struck with surprise at the ponderous gear necessary for producing each of the two lights employed there.

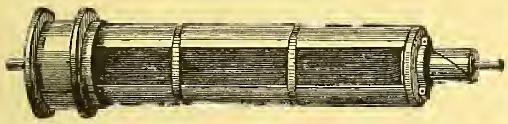


Fig. 4.—SIEMENS' ARMATURE (EXTERNAL APPEARANCE).

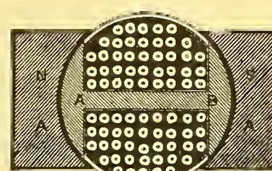


Fig. 5.—END SECTION.

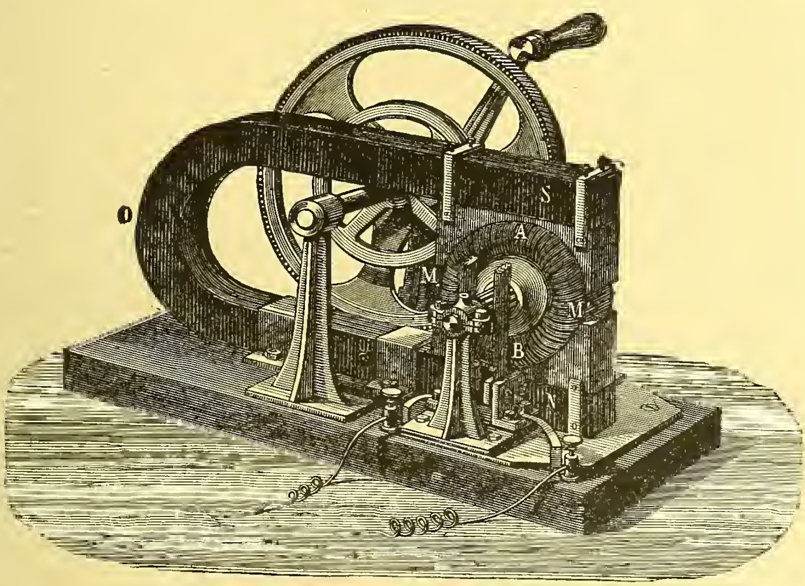


Fig. 6.—LABORATORY GRAMME MACHINE.

A notable advance in the history of these machines was made in the introduction by Siemens of a new form of coil, or armature, which is still known by his name. In this armature the wire, instead of being wound on the core like a reel of cotton, is wound longitudinally, like a weaver's shuttle. The way the wire is wound is shown in Fig. 4, but the nature of the armature is better shown by the cross section in Fig. 5. Here A B represents what is left of the iron core after the deep channels have been cut for the wires, which are shown in section. The whole revolves between the hollowed cheek-pieces, N A and S A, which are in contact with the north and south poles of the magnets; and the effect is that the *sides* A B of the armature, whenever they come into the positions shown in Fig. 5, are strongly magnetised, and send currents through the wire, which are reversed in direction when the armature is rotated a quarter of a circle. The length of the armature enables it to be rotated between long cheek-pieces connected with as many magnets as may be desired; and its compact shape renders it easy of revolution. Celerity of rotation is a very important factor in the efficiency of these machines, the strength of the current depending largely on the suddenness with which the core of the armature is magnetised or demagnetised.

Next came an improvement from Wilde, of Manchester, who caused a Siemens' armature to be rotated in the jaws of a compound magnet, consisting of a number of horse-shoes bolted together. The current thus obtained was conveyed to a large electro-magnet, and between the poles of this second magnet a larger armature revolved. The strength of the original current was, of course, much reinforced by this double arrangement. The next advance made in these machines was comprised in a suggestion simultaneously made by Siemens and Wheatstone, that there was sufficient residual magnetism in soft iron to initiate a current, without the intervention of a permanent magnet. This suggestion was made in 1867, and has been acted upon in all machines, with hardly one exception, which have appeared since that date. These machines are now known as dynamo machines, to distinguish them from those which have permanent magnets, although both kinds are dependent upon the dynamical power of a steam-engine or other motor to rotate their coils.

The introduction of these machines led to the adoption of the electric light in several lighthouses, but the cumbrous nature of the plant, together with the steam-power required to set it in action, prevented its employment in positions where expense had to be considered. A new era dawned for electricity with the invention of the Gramme machine, which is now commonly used not only in France, but also in this country, for lighting, and for electro-plating purposes.

In the Gramme machine the rotating coils give place to a new form of armature, consisting of a ring of iron, or rather, a bundle of iron wires of annular shape. Insulated coils of copper wire are wound upon this ring in sections, their ends being brought together to the axis, on which the ring turns between the poles of a powerful electro-magnet. As the ring turns it is magnetised inductively by the electro-magnet, and the currents generated in its coils are collected by metallic brushes, which rub against the shaft on which it turns, and to which the terminals of the coils are carried. The ring armature was first invented by Pacinotti, in 1860, and a rough machine in which it was employed was exhibited at the Paris Electrical Exhibition of 1880, where it attracted much attention. But in the Gramme machine, whose inventor may be said to have re-discovered the principle of the ring armature, it was first made a practical success, and adopted in practical dynamo machines.

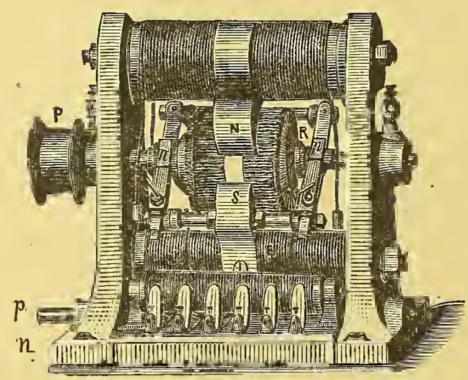


Fig. 7.—GRAMME DYNAMO MACHINE.

Let us first glance at a small Gramme machine, as constructed for lecture-table demonstration (Fig. 6). Such a machine is a boon to lecturers, for with it the chemical, calorific, and magnetic effects of the current can be exemplified by the turning of a handle, thus obviating all the trouble and mess incidental to a voltaic battery. A number of permanent magnets are bolted together (O), and are so fixed on a base-board that their poles (N and S) are vertical. These poles are furnished with cheek-pieces, which form semicircular jaws in which the ring rotates. The effect is that as the ring is rotated, every portion of the iron core becomes strongly magnetised in succession as it approaches the positions A and B, while it is demagnetised at the neutral positions, M M, between the poles. Thus currents are produced in the surrounding wire, and the rest follows as before.

The Gramme machine for commercial purposes (Fig. 7) is, of course, of far larger size and of greater power, and cannot be worked without a steam-engine or other motor. Here the permanent magnets are superseded by electro-magnets, which form horizontal bars above and below the ring (R). The cheek-pieces (N and S) are retained, and the brushes (*n n*), for gathering the current from the ring, are seen on each side of it. It is this description of machine which has been in use for many months for furnishing the current required for illuminating the Thames Embankment; and it was the same machine which, by its use in Paris to light up the Place de l'Opera with Jablochkoff candles, led to the magnificent French Electrical Exhibition of 1881, and gave such an impetus to electric lighting generally. These machines are placed in a shed erected for the purpose near Charing Cross Railway bridge.

In another article we shall give a description of the dynamo machines which have come into prominence within the past few years; and we shall then be able to see how the simple experiment with Faraday's magnet has led up to important results, which even that great scientist, with all his foresight, could hardly have imagined or believed possible.

CRIMES DISCOVERED THROUGH DREAMS.

MARIA MARTIN.

MARIA MARTIN was the daughter of a Suffolk mole-catcher, who resided at Polstead. She had a very pretty face and a beautiful figure, was simple and artless, and readily fell a prey to the insidious advances of William Corder, a wealthy farmer's son. On the 18th of May, 1827, he promised the father of Maria that he would marry his daughter privately by licence, and for this purpose she was to be in readiness to go with him to Ipswich, dressed in male attire, which she could exchange on the way for her own clothes in one of his barns, known as the Red Barn. They met secretly at some distance from her father's house, and walked on together. From that time forth she was never seen again alive. Her mother questioned Corder, who said she was alive and well, in hiding to prevent his friends discovering the marriage, which they had strongly opposed.

Soon after, he left England for the Continent, to benefit his health, as he said, expressing curious anxiety before he started to see the Red Barn well filled with grain. He wrote to his widowed mother, dating from the Isle of Wight, saying he was staying there for a time with Maria; but the letters always bore the London post-mark.

The Martins were, however, very anxious about their daughter, the mother having dreamed on three successive nights that Maria had been murdered and buried in the Red Barn. It was remembered that on the morning when she met her lover at her father's cottage, and they went out by different doors to meet again at some appointed spot, Corder carried a gun, and that when Maria asked him if it was loaded, he said, "Yes." His eagerness to fill the Red Barn with grain, and his working himself to get it so filled before he left home, were also remembered as something strange. He wrote to the Martins, and in one of his letters expressed surprise that they had not received a letter which their daughter had written to them and posted. These things oozed out, and were talked of amongst the neighbours. Maria's brother Thomas also remembered seeing Corder walking towards the Red Barn with a pickaxe over his shoulder about three o'clock on the afternoon of the day when his sister went off to be married.

On the 19th of April in the following year Mrs. Martin persuaded her husband and son to apply for permission to search the Red Barn, on the pretext that Maria had left the clothes in which she went from home there. The grain had by that time been removed. Mrs. Corder did not object, and the search began, Mrs. Martin pointing out the spot she had seen in her dream, and where in that dream she had seen the body of her murdered child buried. There, on the 19th of April, 1828, the body of the missing woman was discovered, buried under the flooring in a sack. No marks of violence were, however, at first visible.

Corder was soon after arrested at Grove House, Ealing Lane, near Brentford, where he was living in apparent happiness with his newly-made wife, who was conducting a school for young ladies. The officers took him back to Polstead, where he was committed for trial on the charge of murder. His wife refused to believe him guilty, and visited him almost daily. He was tried in the Shire Hall at Bury St. Edmunds, in the midst of the most extraordinary excitement, and on the way to trial was assailed on all sides with a terrific uproar of abusive shouts and groans. He made a very elaborate and ingenious defence, in which he attributed Maria Martin's death to suicide, in consequence of his refusal to marry her; but was found guilty, and sentenced to death. Before being executed he confessed the justice of his sentence, stating that they had quarrelled in the barn, where he shot her, the ball entering her brain through the right eye.

AN IDIOT DETECTIVE.

MODERN criminal cases have shown us that we are not entirely wanting in idiotic police detectives, but we have not at present, perhaps, many of an actual idiot playing the detective's part. The following case is related in an old number of the *Dublin Penny Magazine*, which ceased publication many years ago. Ulick Maguire, a farmer, had given shelter and food for some time to a poor cousin, who was an idiot. One night Ulick's wife dreamed that her husband was murdered, and the dream was associated with the house of a rejected lover of hers, named O'Flanagan. She told this to a neighbour's wife, who soon after heard the idiot, to whom it had not been told, chanting the strange incidents of that dream in doggrel rhyme. On the following night the husband actually was murdered, and when the idiot awoke in the morning, he cried out in terror, "Shanus dhu More O'Flanagan (big black James) has kilt Ulick, and buried him under the new ditch at the back of the garden. I dhramed it last night, ivry wurrd of it." Search was made at the spot the idiot indicated, and the body of poor Ulick was found, with the skull cleft in two. It was soon found that O'Flanagan had absconded. He enlisted, but being traced and arrested, he confessed the crime, and was executed.

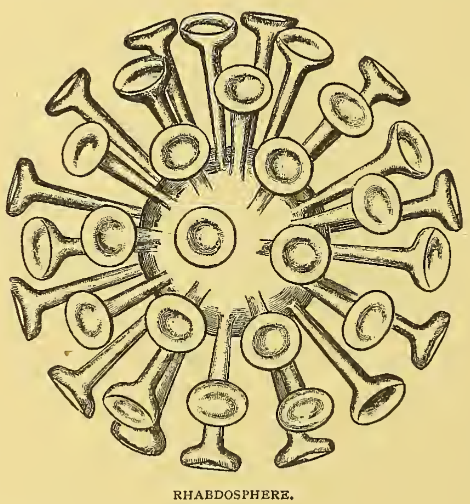
THE CASE OF JOHN STOCKTON.

JOHN STOCKTON was a victualler of Grub Street, in the parish of St. Giles, Cripplegate. In the night of December the 23rd in the year 1695 his house was broken into and he was murdered, it was believed, by three robbers, one of them being, as was suspected, a man named Maynard, who on the day after the murder was known to be in possession of money in gold and silver, which he had not previously had, and was in need of. A warrant was issued for his arrest, but the man had escaped and could not be discovered.

A woman named Greenwood soon after had a dream in which her late neighbour, the murdered man, appeared, took her to "a house in Thomas Street near the 'George,' and told her that his murderer was inside it." On the following morning she went to the house she had seen in her dream, taking a neighbour with her; and, asking to see Maynard, was told that he was no longer there, and had gone abroad. The murdered victualler appeared to the woman again, and showed her Maynard's face, which she had never seen; made her notice that he had a flat mole on the side of his face; and told her that he was to be taken through a wire-drawer, and would be conveyed to Newgate in a coach. Making further inquiries, she found that there was a wire-drawer with whom the suspected man had been on the most intimate terms, and he, for a reward of ten pounds, lured Maynard from his hiding-place and betrayed him. After being taken before a magistrate for committal, he was conveyed to Newgate in a coach. There he confessed and gave up the names of his accomplices, the chief being a villain named Marsh. Neither he nor another named Bevel could be discovered.

Stockton re-appeared to the woman in a third dream, carried her in imagination to a house she had never before seen in Old Street, and told her that one of his murderers lodged there up a pair of stairs, which he also showed her. Inquiries being made, the house was found, and it was ascertained that Marsh (who was soon after taken in another place) was a frequent visitor to it.

Then Mrs. Greenwood dreamed yet another dream. She thought that Stockton carried her over London Bridge into the Borough, and showed her a man and his wife in a large yard, telling her that they were Bevel and his wife. Following up this clue, the authorities found them in the yard of the Marshalsea prison, to which Bevel had been committed for coining. Mrs. Greenwood went with the officers to identify the man, and did so. She saw the woman first, and directly pointed her out as Bevel's wife, but did not at first recognise the man, because she said he wore his wig, which was off when she saw him in her dream. Mrs. Greenwood had yet another dream, in which Stockton appeared for the last time and thanked her.



RHABDOSPHERE.

One thing is particularly noted as curious in this most strange and wonderful story: the only man who escaped was one named Mercer, whom it was shown protested against the murder, refused to take part in it, and once saved the life of a Mrs. Footman, who was Mrs. Greenwood's friend, and her companion when visiting the various places pointed out in her dreams.

An account of the above extraordinary case was published in 1689 by the curate of the parish in which the crime was committed, and its truth was vouched for by the Dean of York, the Master of the Charter House, and Dr. Alex, together with the various persons who took part in its action.

THE BOTTOM OF THE ATLANTIC.

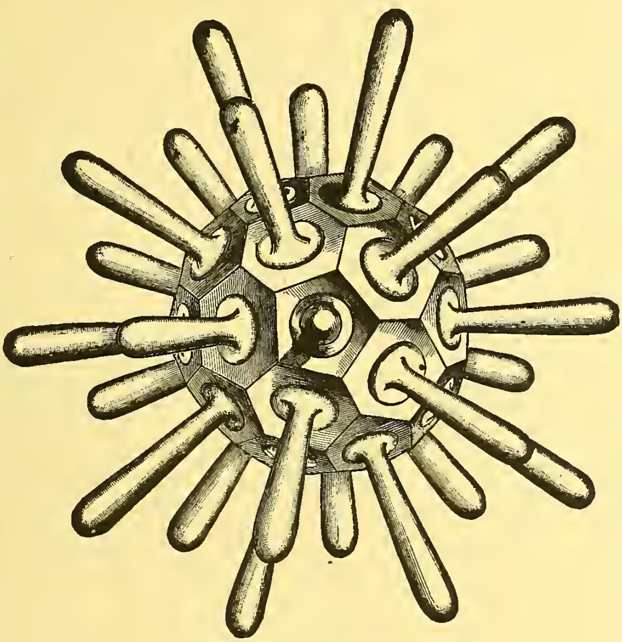
DURING the voyage for scientific purposes of H.M.S. *Challenger*, a very important line of soundings was run across the widest portion of the Atlantic, from Teneriffe on the eastern side to the island of Sombrero on the western. This distance is about 2,700 miles, and the course followed may be considered as coinciding very approximately with the Tropic of Cancer, or latitude 23½° N Along this line twenty-two important sounding and dredging operations were successfully accomplished. The average intervals between the "stations" was 120 miles. At each at least one sounding was taken, and ample specimens of the bottom were brought up in the dredge for examination. The greatest depth found was 3,150 fathoms, *i.e.*, nearly 19,000 feet. The special objects sought were, to ascertain the depth of the water, to discover the nature of the bottom, to find out the temperature at each 100 fathoms of depth down to 1,500 fathoms, and the temperature at the bottom, to test the specific gravity of the ocean at various depths, and to inquire most particularly into the nature of animal and vegetable life at all depths. In every instance careful observations were made of the temperature of the air with both dry and wet bulb thermometers, and of the state of the atmospheric pressure by a standard barometer.

The bottom was found to be a plateau with comparatively gentle undulations, but of great extent. About two-thirds of the way across a remarkable elevation of the bed of the ocean occurs. This has been called the "Dolphin Rise," after the United States surveying vessel, from which its position was first determined. The depth of water on it is about 2,000 fathoms, whereas in the troughs to east and west of it there are depths exceeding 3,000 fathoms.

The average temperature at the surface along the section is 71° F., at a depth of 500 fathoms it is 44° F.; at a depth of 1,000 fathoms it is 39° F.; at 1,500 fathoms it is 36½° F.; and at the bottom it is only 3½° above the freezing-point of water.

The nature of the bottom was found to be of very unexpected interest. After a space of eighty miles of volcanic mud and sand, obtained from the volcanic rocks and mountains on the eastern side, there comes a length of 350 miles of what is called "Globigerina Ooze"; next follows an immense stretch of 1,050 miles of the now famous "Red Clay"; then follows an interval of 330 miles of Globigerina Ooze, succeeded by another great section of 850 of Red Clay, and the last forty miles before reaching Sombrero are Globigerina Ooze. Thus there is a total length of 1,900 miles of Red Clay, and 720 miles of the Globigerina Ooze. It was also noticed that wherever the depth increases from 2,200 fathoms to 2,600 fathoms, the Globigerina Ooze passes into the Red Clay.

The former, or "modern chalk," is found to consist first of all of a creamy surface layer composed of shells, mostly unbroken, of *Globigerina*, *Pulvinulina*, and *Orbulina*, with a small proportion of the tests and spines of surface creatures, and fragments of the spicules of sponges. Mingled with these are found many shells of pteropods in a more or less mutilated condition. Annexed are illustrations of extremely beautiful little bodies (*Rhabdospheres*) which live abundantly on the surface of warm seas, and whose skeletons, falling on the bed of the ocean, enter largely into the composition of the recent deep sea calcareous formations. They are taken by permission from "The Voyage of the *Challenger*." Below this layer there is another, an inch or two thick, of greater consistency, in which are found broken shells of great variety cemented together by a calcareous paste, and below this again there exists a nearly uniform calcareous paste, coloured grey by decomposed organic matter, but containing very few shells of any kind.



RHABDOSPHERE.

As the depth gradually increases down the slope of one of the undulations above referred to, there is also a gradual change in the nature of the bottom. The calcareous deposit slowly passes into and is at last replaced by an extremely fine and pure clay. This clay has the colour of chocolate, and is so smooth that, when sifted, not the least grittiness can be detected if rubbed between the fingers, and if shaken in a glass bottle containing water, several days elapse before it is precipitated on the bottom.

It is found to consist very largely of red oxide of iron and alumina ; but sometimes are found mixed with it particles of manganese, and, in volcanic regions, fragments of pumice. As the depth increases from 2,200 fathoms, the shells of the mollusca, which are constantly falling on the bottom, are found to be more and more decomposed, they become brown and worn, and finally break up into fragments. Now a considerable portion of the fine molecular matter of this "Red Clay" is the insoluble residue, or, as it may be termed, the *ash* of calcareous organisms which form the Globigerina Ooze, after the lime, which forms about ninety-eight per cent. of the latter, has been removed by some means. In all animal tissues there exist, besides the salts of lime, various other inorganic salts, and it is probable that in the decomposition of these tissues by salt water and the various chemical substances therein contained, these salts may pass into the form of silicate of alumina and sesquioxide of iron.

As an important gain to science resulting from this series of soundings, we may mention that on one occasion when the dredge was recovered from a depth of 3,000 fathoms, there were found entangled about its mouth long cases of a tube-building *annelid*, evidently formed out of substances which are found in the "Red Clay." The worms contained in these cases were very carefully examined by the competent authorities on board the *Challenger*, and the conclusion arrived at has very materially changed the prevalent opinions about the possibility of animal life at vast depths. The little creatures were found to be closely allied to the *Clymenidæ*, a well-known shallow-water group of high organisation. The largest specimen dredged was only 120 millimetres long and two wide, and consisted of only twenty segments, the first few of which were three times the length of the others. The head was round, with a lateral mouth. It was fortunate in possessing attributes which made it simply impossible that it could have been captured during the passage of the dredge to the surface. It appeared a conclusive proof that the conditions of the bottom of the sea *to all depths* are not only such as to admit of the existence of animal life, but are such as to allow of the widest distribution of animals high in the zoological series and in close relation with the faunæ of shallower waters.

A ROMANCE OF THE COTTON TRADE.

HISTORY furnishes few greater wonders than those which are connected with the rise and rapid growth of our great manufacturing and commercial houses; and of these, those connected with the most stupendous of all our manufactures and trade—cotton—have been the most remarkable. In 1781 the quantity of cotton wool imported into Great Britain was about 5,000,000 lb., and twenty years before, the entire value of all the cotton goods manufactured for export and home consumption in a year was valued at £200,000. In 1829 the quantity imported was upwards of 218,000,000 lb., of which about 40,000,000 lb. were exported in yarns valued at £3,500,000 sterling. In 1844 the declared value of cotton goods for export alone amounted to £25,805,348, and the quantity retained for home consumption was estimated at the value of £10,000,000 sterling. In 1860, before the civil war broke out between North and South America, we imported about 1,400,000,000 lb. of cotton. In 1784, when the first eight bales of American cotton arrived in Liverpool, they were seized by the custom-house officers as contraband. The first steam-worked English cotton-mill was erected in 1790, and in 1840 there were in the United Kingdom 2,500 such factories.

This enormous trade began where its great centre still is, in Lancashire, and made its wonderful progress despite the greatest difficulties, and in despite of the most desperate opposition from every conceivable kind of restriction. Before 1790 America did not export a single pound of cotton, and our supplies were derived from Smyrna and Turkey, from Brazil, from the British West Indies, and from the colonies of France, Spain, and Holland, while the cotton manufactures of Hindustan and China defied opposition. For a century after the French Protestant emigrants introduced it, the manufacturers of silk and wool employed every species of antagonism and unfairness for its restraint.

In 1712 an excise duty of threepence per yard was imposed, in 1714 it was raised to sixpence, and in 1721 the manufacture of cotton was absolutely forbidden, a penalty of £20 being inflicted for selling it, and one of £5 upon all persons convicted of wearing it. In 1736 the making of calicoes was again permitted, but on the condition that if the woof was cotton the warp must be entirely linen ; and it was not before 1744 that these restraints were removed, and the earliest foundations laid for this wonderful branch of trade and manufacture.

THE PEELS OF MANCHESTER.

William Peel, who set himself up as a farmer near Blackburn in the year 1600, came of an old Yorkshire family which had settled in Craven, and been driven away by troubles arising out of religious convictions, as tradition asserts. The spot he selected was one amidst lands formerly owned by some of his ancestors, called, from the lowness of its site, the Hoyle Farm ; and there, with his aged father and three brothers, he settled down to a life of steady industry, his landlord being the Archbishop of Canterbury.

His grandson, Robert Peel, deserted farming for weaving, or, perhaps, in a way then common, carried on both trades, manufacturing, in 1640, common woollen cloths, the patterns on which were printed from coarsely-executed, rudely-designed wooden blocks, which were long after in the possession of the family. He prospered in trade, and left two sons, Robert and Nicholas. One became a clergyman, and was curate of Blackburn, while his brother, Robert, carried on the cloth-making, and soon after 1736 entered into the cotton trade, by manufacturing the newly legalised mixture of linen woof and cotton warp, which became known as Blackburn greys. Beginning to prosper, he bought an estate called The Crosse, afterwards known as Peel Fold, which he settled by deed upon his son William, who was to become its owner after his father's death. Robert bore the character of an enterprising, hospitable man. William Peel was a sickly man, wanting in energy and vigour. The business he inherited from his father was not developed while he had charge of it. His wife was a Miss Ann Walmsley, of Upper Darwen.

His son, named Robert after his grandfather, was a shrewd, quick-seeing, active man of business, although shy and reserved, who carried on the cotton-weaving with great industry, energy, and perseverance, after he had removed from the unhealthy, low-lying Hoyle Farm to a house in Fish Lane, Blackburn. He was born at Peel Fold, and was married to Elizabeth Haworth, of Lower Darwen, whose father, Mr. Edmund Haworth, of Walmsley Fold, was a descendant through a junior branch of the Haworths, of Haworth. His third son, the first Sir Robert Peel, was born in the Fish Lane farmhouse, and he, writing of his father, said, " He moved in a confined sphere, and employed his talents in improving the cotton trade. He had neither the wish nor the opportunity of making himself acquainted with his native country, or society, far removed from his native county of Lancaster. I lived under his roof until I attained the age of manhood, and had many opportunities of discovering that he possessed in an eminent degree a mechanical genius and a good heart. He had many sons, and placed them all in situations where they might be useful to each other. The cotton trade was preferred, as best calculated to secure this object; and by habits of industry, and imparting to his offspring an intimate knowledge of the various branches of the cotton manufacture, he lived to see his children connected together in business, and, by their successful exertions, become, without one exception, opulent and happy. My father may be truly said to have been the founder of our family; and he so accurately appreciated the importance of commercial wealth in a national point of view, that he was often heard to say that the gains to individuals were small compared with the national gains arising from trade."

He who wrote thus of his namesake and progenitor inherited all his father's good qualities, and in or about 1774 (some authorities say 1770), when the cotton manufacture was at last freed from its harassing legal restrictions, he and James Haworth—his uncle on the mother's side—and William Yates, the landlord of a little inn at Blackburn called the "Black Bull," put what capital they could command together—£500—to start in business as calico-printers. Robert was then a young man, who lodged with Yates and paid eight shillings a week for his board and lodging. His share of the capital—of which Yates' was the largest—was advanced by his father. The partners began work in the ruins of an old corn-mill and the field belonging to it, in which sheds were erected. It stood close by the then small and obscure town of Bury, and was long after known as " The Ground." Mr. Samuel Smiles tells us that the eldest daughter of Yates was at this time a child who became a great favourite with Robert, used to sit upon his knee and prattle to him, and promise to be his wife.

In due time the firm of Haworth, Peel, and Yates began to flourish, and established a warehouse in Manchester for the sale of their printed goods, effecting considerable improvements in their spinning machinery, greatly benefiting the people of Bury, and establishing other and more extensive works on the Irwell and the Roch, winning the goodwill of all they employed for a time. All went well until the firm began to improve their machinery, which "gave offence," says Sir Lawrence Peel, " to the hand-loom weavers of the neighbourhood, and was not looked upon altogether with a friendly eye by some in a superior station. A skilled mechanic, whom the firm employed in working out their inventions in machinery, was kept for a time concealed in the private house of Mr. Haworth, and worked there in secret, as if he were engaged in some mystery of wickedness. In the course of their experiments in printing, they introduced some improvements also in that art, but I know nothing as to their nature or degree of importance. . . . One story of several which are in print I am able to confirm. Mr. Peel was in his kitchen making some experiments in printing on handkerchiefs, and other small pieces, when his only daughter, then a girl, afterwards Mrs. Willock, the mother of the postmaster of Manchester, brought in from their 'garden of herbs' a sprig of parsley," the beauty of which she enthusiastically pointed out, and thought it would make a good pattern. A pewter dinner-plate, such as were then in common use, was taken down, and on it the outlines of the leaf were scratched, and the indentations being filled with colour, it was taken by Robert to a young woman named Elizabeth Milton, who occupied one end of the Fish Lane farm-house, and worked a calendering machine, by the aid of which an impression was obtained from the pewter upon the cloth. From this experiment came roller-printing on calico. Sir L. Peel omits this portion of the story, which rests upon the statement made by Elizabeth Milton's daughter. The popular parsley-leaf pattern—Nancy's pattern, as it was called in her family—became historical, and gave the inventor a nickname which he never lost, that of "Parsley Peel."

When James Hargrave, of Blackburn, a weaver, invented the spinning jenny, by which several threads were spun at once instead of separately, Peel's firm was amongst the first to adopt it, and thereby drew down the vengeance of the riotous weavers, whose destructive work and deadly threats drove Robert Peel from Blackburn to Burton-upon-Trent, in Staffordshire, where he erected, near the River Trent, three mills, to supply one of which with water he cut a canal at the cost of £90,000. From that time forth he pursued a career of uninterrupted and wonder-moving prosperity, and in process of time the entire town of Bury became, says the author of "The Romance of Trade," "a sort of appendage to Peel's factories, and, in consequence of his great success, its population steadily advanced from about 2,000 in 1773, to upwards of 15,000 in 1831."

It will add interest to the story of this wonderful uprearing of a mighty fortune and a great family, if we add that pretty little Nelly Yates, who, when a child, sat upon the knee of Robert Peel and prattled to him so freely, and promised to become his wife if the young lodger would wait for her, as he said he would, really was waited for, and really did become his wife. When they married he was thirty-six years of age and she seventeen, and her father, the once poor innkeeper, was rich enough to give with her a large dowry. She lived to become Lady Peel, and the mother of one who became Prime Minister of England. For many years after her marriage she played a prominent part in advancing her husband's fortunes, being his amanuensis, and conducting the principal part of his business correspondence, for Mr. Peel was himself an almost unintelligible writer. She died in 1803. It is said that London fashionable life, so unlike her old life at home, proved injurious to her health, and that her father used to say, "If Robert hadn't made our Nelly a lady, she might ha' been living yet."

Sir Lawrence Peel writes of the first Sir Robert of his family saying, "He understood thoroughly every branch of the cotton trade. He instructed his sons himself; he had no drones in his hive. He loved to impress upon their minds the great national importance of this rising manufacture. He was a reflecting man who looked ahead; a plain-spoken, simple-minded man, not illiterate or vulgar either in language, manners, or mind, but possessing no refinement in his tastes, free from affectation, and with no desire to imitate the manners or mode of life of a class above his own." Describing his personal appearance, the same author said, "When he walked the streets of Burton he used to look downwards, and seemed to ever be calculating some stiff question. . . . . He stooped a little in his latter days; in his youth he had been remarkably erect. He wore a bushy Johnsonian wig, was dressed in dark clothes of ample cut, and leaned as he walked upon a tall gold-headed cane."

Other great cotton firms were established while Sir Robert's attained its dominant greatness, by members of the same remarkable family, at Burnley, Foxhill-bank, and Altham in Lancashire, and at Salley Abbey in Yorkshire.

THE CAVES OF BELLAMER.

To the eastward of Havana, on the north coast of Cuba, is situated the large and handsome city of Matanzas. The rocks in the neighbourhood are principally the Guines Limestone, so called by Humboldt to distinguish it from a much more modern formation in the hills near Trinidad, on the south coast of the island. In this rock, about two miles to the south-east of the town, are situated the famous caves of Bellamer.

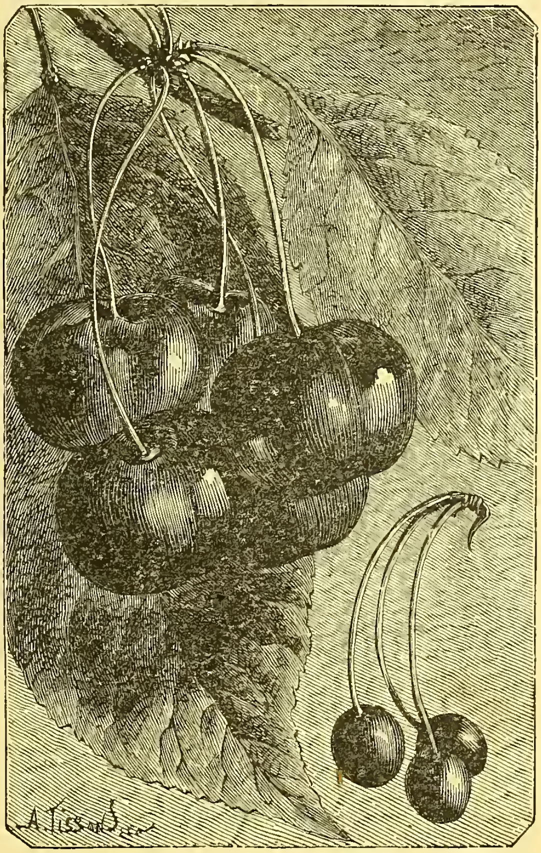
These were discovered by an accident about the year 1860. Some workmen were engaged in a field when the crowbar of one of them suddenly disappeared through a hole which he had just made. This led to a further investigation, and the interesting result was the discovery of another "wonder" in Nature's inexhaustible store.

Access to the caves is had by a wooden staircase. Each visitor is supplied with a torch in the form of a huge bees'-wax candle attached to a short stick. The guide, or *muchacho*, leads the way, the visitors following the narrow path in a long procession. The greater part of the caves, which have so far been explored for nearly three miles, is dry under foot in most places, and their varied beauties can be seen under unusually favourable conditions. Crevasses, some of which are of great depth, are spanned by carefully constructed wooden bridges, and wherever necessary steps have been cut in the solid rock.

The first open space is reached about forty or fifty yards from the foot of the staircase above mentioned. To this the not inappropriate name of the "Gothic Temple" has been given. The chamber is about sixty yards long by twenty yards wide. As the visitor stands at its farther end and looks towards the entrance, the effect is very fine, and especially so when blue lights are held in different parts. The roof sparkles with thousands of crystals, and gloomy and fantastic shadows are cast by the columns and irregularities in the sides. Here are three solitary stalactites, known as the "Three Apostles." We next pass on to the "Saloon," and then arrive at the "Bishop's Court," or "Throne." In the passages from one to the other, the guide points out the "Mantle of Columbus," the "Organ," the "Altar," the "Monkey's Seat," the "Guardian Angel," the "Fountain of Snow," and the "Cloak of the Virgin." When a light is passed to and fro before the "Mantle," it sparkles and glitters as though it were adorned with many jewels. The term "Cymbal" might with some reason be given to another stalactite on account of the rich musical note which it gives out if struck with a wooden pole. When the *muchacho* held several torches behind the "Cloak of the Virgin," the colours thus produced were very fine, passing according to the varying thicknesses of stalactite from grey into a pure white, and then through rose and pink into a lovely amber or blue. Remarkable as these more prominent objects certainly are, we must not close this notice without mentioning the rich and extremely delicate appearance of the tracery on the roof in many places from the intertwined stalactites. Without attempting to assert any close resemblance, we would say that to those who have seen both, the roof of Henry VII.'s Chapel in Westminster Abbey and some parts of the caves of Bellamer will help to recall each other to the mind of the traveller.

CULTIVATED AND WILD FRUITS.

As fallible human beings we are accustomed to take our lessons from Dame Nature, and to look upon her and her works as things which are beyond our rivalry, and which cannot be improved. We rightly "consider the lilies of the field" as the type of simple, unadorned beauty; and we well know that the endeavour to improve those lilies by a coat of paint is the proverbial expression of wasted energy, and very bad taste. We have seen in a former article how the finest work of man, when placed on the stage of the microscope side by side with some similar forms borrowed from Nature's workshop, look, in comparison, rough and ill-shaped. So the law has been by common consent laid down—that we must look to Nature for our instructions in excellence of every kind, and that we need not try to improve that which, by Nature's God, has been so bountifully placed before us.



CULTIVATED AND WILD CHERRIES.

Like all laws, this one has its exceptions. A little consideration will teach us that man, insignificant as he is when contrasted with the grand scheme of the universe, is capable, to a large extent, of improving natural productions. The first example of his work in this respect may be taken from those cereals which form the most necessary part of his food. Originally growing wild, but at a period so remote that the country of their origin is unknown, these grasses have been so carefully tended and cultured by human hands, that the weeds which once were their fellows would now not recognise them.

Our most cherished flowers have in like manner been brought by high culture to a perfection which never could have been obtained without that culture. Our fruits, if we look into their pedigrees, have extremely vulgar ancestors, and they owe their present size, appearance, and flavour to the finished education received at the hand of man. Compare, for instance, the two fruits shown natural size in our illustration. One is the wild cherry of the woods—the vulgar ancestor just referred to; the other is its improved and refined descendant. The first is almost flavourless, and of such a size that the little flavour it has can hardly be distinguished; the other is the luscious and highly-prized cherry known as Belles de Montreuil. We know well enough that art cannot create; nor can science and art put together explain the secret of that vital principle that exists in the meanest vegetable growth. But the two have worked hand in hand in improving by careful culture, and the cherries form a remarkable example of the success of their labours.

DRINKING EXTRAORDINARY.

THERE is no telling what a man's stomach will stand; it seems to adapt itself, along with the other organs, to any excesses he may habitually indulge in. The Eskimo eating his *ten* pounds of flesh daily in addition to other odds and ends, or the brewer's drayman imbibing his gallon of beer—both become accustomed to it, and can carry it on for a time with impunity. Great drinkers were known in ancient times, fellows like the—

> Jolly old toper! who at a pull,
> Could drink a postillion's jack-boot full,
> And ask with a laugh, when that was done,
> If the fellow had left the other one!
>
> LONGFELLOW'S "*Golden Legend.*"

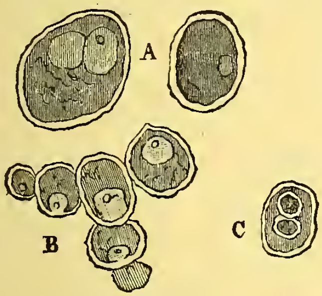
Such a man was Torquatus of Mediolanum, who lived in the reign of the Emperor Tiberius. On the authority of Pliny, it appears he was able to drink off at one draught three gallons and three pints of wine, and with it all attend to his duties as a soldier and servant of the state. Of a lesser stomachic capacity was M. Cicero, the son of the famous orator, who was able to drink off two gallons and two pints of wine at one draught. One is strongly inclined to think that there must have been some jugglery practised by these men, for perhaps the most extraordinary feat of the same kind performed in modern times is that of the drinking of only a gallon and a half of beer in half a minute, by one Farbaugh of Cincinnati! It seems somewhat odd that this modern toper—unequal as he is to the foregoing—should be also connected with a place bearing a classical name.

THE WORLD OF LOWER PLANTS.

THE world of plants includes within its limits very varied beings, both as regards size, form, appearance, and beauty. Perhaps of these varied aspects, however, none are better calculated to strike us with surprise than those which, under the one name of "plants," present us with forms which, like the great *Sequoia* or *Wellingtonia* of California, tower for several hundreds of feet above the earth-level, and also with beings so minute that thousands of them will people a water-drop, and millions be included within the compass of a square inch. Yet such are, in truth, the two extremes of the plant-world. The mighty tree and the minute organism are alike included within the botanist's domains, and the microscopic plant may present to the scientific eye and understanding mind as high a degree of interest as the giants of the forest themselves.

The lowest and most minute of plants live in the water—the sea and fresh waters possessing each their tenants. Their colours are very varied. They present us with green, bluish-green, and brown masses, often of considerable size. Some of the sea plants are thus of very large extent, others again are excessively minute. But one and all are composed of the small bodies known as *cells*, and the variations in form and size are due in reality to the manner in which the cells are arranged. The lower plants, as a class, are named *Algæ.* The simplest of them exist as single cells; and these often produce other cells which repeat, as plants, the single and solitary state of their parents. Others again form great masses of cells, and thus show us the power of numbers and the strength of little things. One of the most curious plants with which the world of minute life is peopled is the well-known "Yeast-plant." Each "yeast-plant" is a microscopic cell, about the $\frac{1}{3000}$th part of an inch in diameter; that is to say, it would take 3,000 yeast-plants placed in single file to make up the length of one inch. Yet humble as this plant is, the effects of its growth are highly important. Whenever any fluid containing "yeast" is added to a solution of sugar, the process called "fermentation" is set up. In other words, this fermentation is to be regarded as the natural result of the growth of the yeast-plant. The action causes alcohol to remain behind, whilst bubbles of a gas (carbonic acid) are given off. When yeast, possessing this singular power, is examined under the microscope, the characteristic little plants in the form of cells are seen floating therein. Reduced to a dry powder, yeast will retain all its fermentative powers for a considerable time. The little plants appear when dried to preserve their vitality, and are capable, when added to a sugary fluid, of producing fermentation. If the yeast or the sugary fluid be boiled, fermentation does not occur. In the one case, the boiling kills the plants, in the other the chemical composition or nature of the fluid is altered. If we strain the yeast by passing it through a fine filter, we prevent fermentation; in other words, we keep back the "plants" from entering the fluid. And, lastly, if, after boiling the fluid, we prevent any air from coming in contact with it, or if we filter the air through cotton wool, we again prevent fermentation. It is thus clear that the small solid specks we name the "yeast-plants" are the cause of fermentative action. What, it may be asked, is the nature of these plants, which are capable of producing such marked effects?

Under the microscope, each yeast-plant is seen to consist of a little wall or envelope, formed of *cellulose*, or starchy substance, familiar enough in higher plants. The substance of the plant consists of living matter, or *protoplasm*, and it is unquestionably in this matter that all the powers and properties of the plant reside. Usually the yeast-plants float singly in their fluids; but many specimens may be seen aggregated in groups, or forming chains. These conditions are produced



YEAST-CELLS.

A. Single Yeast-cell at rest; one with two vacuoles.
B. Chain of cells produced by budding.
C. Cell containing spores.

by the plants giving origin to fresh plants by a process, either of budding—new plants being produced as "buds" by the parent plants—or of internal division. A single plant is seen in this latter process to divide into several masses, each of which encloses itself, like its parent, in a distinct wall or envelope. The parent plant next ruptures, and the young plants escape, several new plants being thus formed by the division of one.

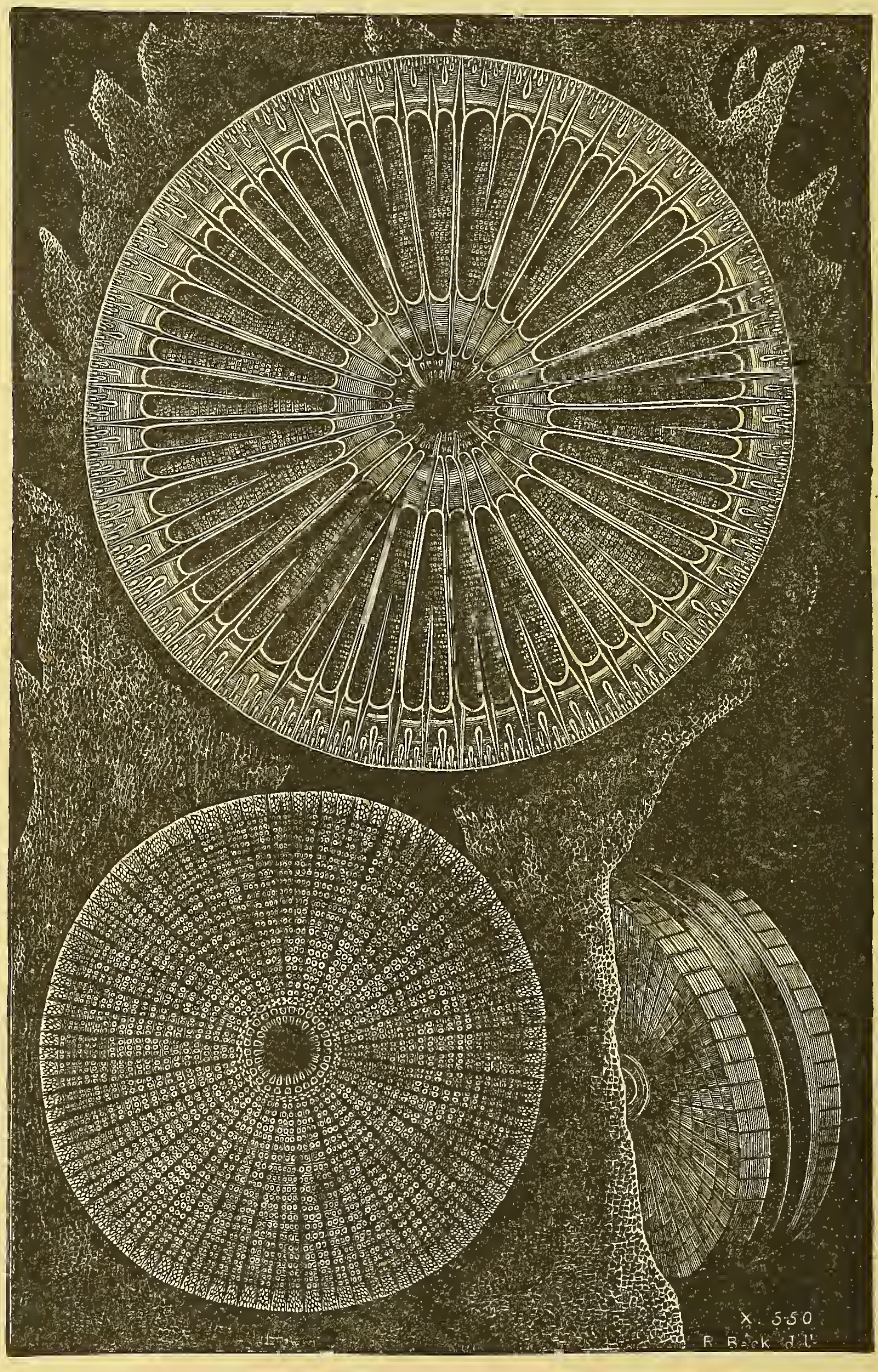
When a sugary fluid exposed to the air "ferments," we know that there must have dropped into it from the air, in which these organisms float as so much dust, some yeast-plants. It may be that only one plant has gained access to the fluid. Such a result is equivalent to the thorough impregnation of the fluid with its species or race. For, on the principle of the little leaven which leavens the whole lump, the single yeast-plant produces in time a progeny, and as the progeny in turn produce others, a short time alone will suffice to people a fluid, and to produce all the characteristic traits of fermentative action. We thus discover how marked a power resides in plants of a very low grade, the yeast-plant being ranked as one of the fungi.

Turning now to a different group of lower plants, we find amongst the *Diatoms* equally interesting and wonderful facts of plant-life. Swarming in both fresh and salt water, the Diatoms are to be found, often clustering on the stems and leaves of water-plants, and forming a plant-family to which attaches an interest of a very high order—a remark which equally well applies to a closely-related family, that of the Desmids. The Diatoms are represented by minute plants, each of which exists as a single cell. Each consists of a little mass of living matter, enclosed between two cases formed of flint. These living specks not merely possess the power of taking flint from the water amidst which they live, but are also able to elaborate their coverings therefrom, and to construct cases which exhibit, as the accompanying illustration shows, a very high complexity of form and structure. The halves of the flinty case in which the living parts of the Diatom reside fit into one another like the two halves of a pill-box. When young Diatoms are produced, the two halves of the case split asunder, and the wall or case of the new plant is seen within the rim of the parent. As in the yeast-plant therefore, new Diatoms are produced by the division of the parent plants.

Nothing can exceed the beauty and delicacy of the markings which the surface of the flinty coverings of the Diatoms exhibits. Microscopists have made these markings the subject of special study, and the various species are recognisable by the special features noticeable on the wall of the cases. Many of the Diatoms exhibit curious movements. The motion appears to consist of a jerking progression which seems to cause the Diatom to move backwards and forwards without actually advancing. The causes of the movement of these minute beings are very obscure; but it is commonly referred to the behaviour of the living matter of the plants, which is believed to be protruded from between the halves of the case. Some authorities appear to regard the motion as dependent on the admission and escape of water to and from the case.

Diatoms, curiously enough, make their appearance in very strange places, and in situations in which their presence would be least suspected. For example, the beautiful species (*Arachnoïdiscus Japonicus*) figured in the accompanying illustration has been found amongst sweetmeats. The three specimens in the plate are represented attached to a piece of seaweed, and as the seaweed is used by the Japanese in making soup, it must follow that this latter fluid will contain many specimens of these Diatoms. The species figured also occurs in guano. It derives its name from the resemblance of the markings on its surface to the filaments of a spider's web. Each half or valve of the Diatom consists of two layers; and it is the outer layer which bears the web-like markings.

There exists in various quarters of the world a peculiar earthy deposit, known as *Infusorial earth.*



DIATOMS (*Arachnoïdiscus Japonicus*) FOUND IN FRUIT PRESERVE.

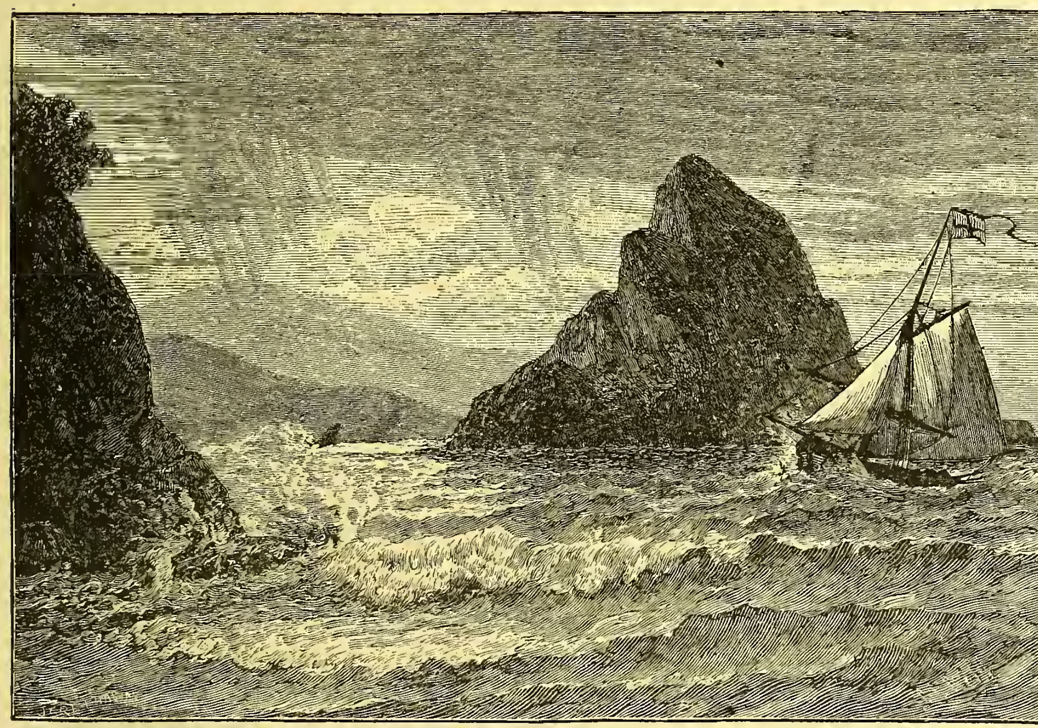
This dust is common at Oran in Algeria, in Bermuda, at Richmond, and in Ireland and elsewhere. In Sweden and Norway similar dust is known as *berg-mehl* or "mountain meal," and is used to mix with the dough from which bread is manufactured. On examining these earths under the microscope, they are found to consist of collections of fossil Diatoms and of the shells of certain low forms of animal-life. The extent of these deposits may be gathered from the fact that at Richmond (Virginia) the "earth" there exhibits a thickness of eighteen feet. The number of diatoms, &c., required to form such a deposit is, of course, beyond any powers of imagination, even the most vivid.

There remains, however, one aspect of lower plant-life which presents features of far higher practical import than are exhibited by the history of the diatoms and their allies. It is a notable fact that all grave diseases that affect humanity and animal-life at large—such as fevers, &c.—are now known to be caused by the propagation, within the bodies of the affected animals, of these lower forms of plant-life. Thus a study of the minute vegetable world, and a knowledge of what happens, for example, when a grain of yeast is sown in an appropriate soil, in reality forms the best preparation for the understanding of the problems of disease. To the lower plants it is now certainly known that we owe many of our ailments; and it is no small triumph of scientific inquiry that we are able to trace, even imperfectly, the causes and origin of many of the troubles that afflict us. This aspect of the matter will be the subject of a separate article.

X

THE DIAMOND ROCK.

To an English sailor there are few objects in the West Indies of more stirring interest than the small isolated rock, which stands about three quarters of a mile from the south-west point of the French island of Martinique, and about six miles south-east of the entrance to Fort Royal harbour. No captain of an English man-of-war hesitates to turn aside in order to give his officers and ship's company the opportunity of gazing on the Diamond Rock, the scene of as gallant an exploit by their predecessors as any of those deeds for which the Royal Navy of England is so justly renowned.



THE DIAMOND ROCK.

It appears that toward the end of the year 1803, the line-of-battle ship *Centaur*, carrying the broad pendant of Captain, afterwards Sir Samuel Hood, was blockading Fort Royal. Finding that vessels frequently escaped capture by running inside the Diamond Rock, the Commodore determined to occupy and to fortify it; in fact, make it a stationary "man-of-war," whence boats could be detached to harass the enemy's trade.

The Rock is about a mile in circumference at the base, and it rises to a height of 600 feet above the sea. The south side is quite inaccessible, being a wall of rock rising sheer out of the water, but sloping inwards near the top. The eastern and south-western sides are also impregnable, but in the face of the latter side are several caves or grottos of considerable extent. The western side has a reef running into the sea, and here is the only landing-place on the whole rock. The landing is sometimes very dangerous, and even at the best of times one must creep on all fours through the crannies till he winds carefully round to the north-west side, as a false step might prove fatal. When this position has been reached, a grove of green wild fig-trees on the slope mounts upwards towards a good-sized cavern.

A landing was effected, and in January 1804, with incredible difficulty, five of the *Centaur's* guns, three long 24-pounders, and two 18-pounders, were landed. A cable was made fast by one end to the rock, and the other end was secured on board. Along this was passed a "traveller," or running loop. To this the gun was secured, and, by suitable tackle, was dragged by the sailors up the sloping cable to the summit of the rock. "Were you to see," writes a private gentleman who was permitted by the Commodore to spend the first few weeks on the island, "how along a dire, and, I had almost said, a perpendicular acclivity, the sailors are hanging in clusters, hauling up a four-and-twenty-pounder by hawsers, you would wonder! they appear like mice hauling a little sausage. Scarcely can we hear the Governor on the top directing them with his trumpet, the *Centaur* lying close under it, like a cocoa-shell, to which the hawsers are fixed. Believe me," the writer adds, in his enthusiasm at the ingenuity displayed in overcoming the many difficulties which presented themselves, "I shall never more take my hat off for anything less than a British seaman."

In front of the slope referred to, and projecting somewhat into the sea, the Queen's battery was built amid the breakers. Here a 24-pounder on a pivot carriage commanded the entrance and nearly the whole of the bay. From this point a covered way was made to another battery called the *Centaur;* this fronted the north-east, and commanded the other side of the sea. It was exceedingly well built, and in it was mounted a second 24-pounder. A rope ladder was fixed between these batteries, and was called the "Mail" by the sailors, as by its means all stores were taken to the middle portion of the island. Here was situated Hood's battery, and in this the remaining 24-pounder was fixed. On the summit, which was reached through shrubs and crags, the two 18-pounders were mounted in Fort Diamond, and the Union Jack was hoisted.

As soon as the guns were duly mounted, and a sufficient quantity of powder, shot, and stores had been landed, Lieutenant James Wilkes Maurice, with the rank of Commander, on the 19th May 1804, hoisted his pendant "on board" the British sloop of war *Diamond Rock*, five guns, and a crew all told of 120 men and boys! and in the official Navy List, the Rock was entered as one of His Majesty's ships in commission!

For more than a year the "vessel" so improvised persisted in firing at and annoying every French ship which passed within range of its heavy guns, and sufficiently carried out the intention of the commander-in-chief. The crews of the ships composing the squadron eagerly sought to do work on the Rock. They regarded it as "going on shore;" and although the labour was heavy, the duties exacting, and food often limited, yet they worked more willingly in quarrying, blasting, building, and mounting guard, than in their own proper duties on board. Several were known to keep back the fact of their being ill, in order to remain in their new craft. A hospital was built, tanks constructed to save the rain-water, the caves were slung round with the men's hammocks. A delicious wild spinach was greatly appreciated by men who had for months been cooped up on board ship. Snakes and lizards were in abundance. The sailors had, as usual, their favourites, a dog, a cat, and a kitten. Fish and fruit were occasionally brought off in shore boats, the owners venturing to approach either for gain or through curiosity. Things went on thus until the summer of 1805, when the French Admiral, Villeneuve, made his famous expedition to the West Indies in order to baffle Nelson's designs. While he lay at Fort Royal with his large squadron, he determined to capture the "Diamond Rock."

In the evening of the 29th May, he despatched the *Pluton* and *Berwick*, both 74-gun line-of-battle-ships, the *Sirene*, a 36-gun frigate, the *Argus*, a 16-gun corvette, the *Fine*, an armed schooner, and eleven gunboats, having on board between 300 and 400 troops of the line, under the command of Commodore Cosmao, to attack the "King's ship." Captain Maurice had anticipated such an event, and seeing the squadron sail out, at once guessed its object, and made his preparations to repel the attack. As it was impossible to defend the lower works, he spiked the guns in the Queen's and Centaur Batteries, and withdrew the ammunition to Hood's. On the morning of the 30th May, the ships had made but little progress, but by the morning of the 31st, they had worked so far to windward that at 7 a.m. they bore down, and at 8 a.m. they opened fire. This was at once returned by the 24-pounder in Hood's battery, and by the two guns in Fort Diamond. The bombardment continued throughout the whole of that and the succeeding day, and did not cease until four o'clock in the afternoon of the 2nd June, when the ammunition of the gallant defenders was exhausted. Captain Maurice hoisted a flag of truce at that hour, and the same evening, between five and six, terms most honourable to the defenders were granted by the enemy. In their defence the English sustained a loss of only two men killed and one wounded. The French estimated their own loss at fifty killed and wounded; but the English commander considered that the loss sustained by a landing party alone was at least thirty killed and forty wounded. Three of the gun-vessels and two of the squadron's boats had also been sunk by the fire from the Rock.

By the custom of the service, Captain Maurice was afterwards tried by court-martial for the capture by the enemy of one of His Majesty's "ships" commanded by him, but was, of course, most honourably acquitted. He was, at the same time, highly complimented for his skilful defence and courageous conduct.

It may be mentioned that the famous rock, which has such an interest for all Englishmen, belongs to the island of Martinique. This large and beautiful island was discovered by the Spanish at the end of the fifteenth century; was colonised by the French about forty years later; was captured by the English in 1762, and restored again by the Treaty of Versailles. After suffering severely in the Great War, it was finally ceded to the French by the Treaty of 1815.

A SINGULAR TRIAL.

On April 15th, 1815, a curious case was tried in the Prerogative Court before Sir J. Nichol. A man named Job Taylor, staff or quarter-master in the Royal Artillery, was drowned, through the sinking of a vessel in Falmouth harbour, together with his wife Lucy, whom his will had appointed sole executrix and residuary legatee. His property was valued at four thousand pounds, and the trial was to decide whether it belonged to the next of kin of the husband, as dying intestate (his wife not having survived him to render his will good) or to the representative of the wife as residuary legatee, she having survived him so as to become entitled to that position; in favour of which view it was urged as presumptive proof that she had the stronger and more robust constitution, and that he was weak and afflicted with asthma. It was urged that the principle of the Roman civil law, which had been adopted into the code of this country, ruled that where two perished together in a common calamity, and it became a question which of the two was the survivor, in the absence of direct evidence, the decision should always be in favour of the one with the more robust constitution and the greater strength. On the other hand it was urged that the husband plunged into the water to save his wife, and that although their bodies were found close together, the probability was in favour of her having expired first. The trial lasted some time, and the judge entered into the arguments on both sides very learnedly, so far as its curious legal aspects were concerned, and also as to the natural facts of the case. He thought, although strong and active, the wife would be timid; and that the husband, although weak, had been courageous and accustomed, being a soldier, to face death in different shapes. In conclusion, the administration was granted to the husband's next of kin.

DYNAMO-ELECTRIC MACHINES.

The celebrated "Gramme" dynamo-electric machine—which has already been described in a former article—marked, as we then indicated, the commencement of a new era in the history of electrical science. Its compact form and small size were in such favourable contrast to the bulky and clumsy arrangement of bobbins and magnets which it superseded, that manufacturers could consider the question of electric illumination without the thought that its introduction meant the advent of an immense bulk and weight of apparatus into their premises for which they could afford no room. But the little Gramme machine could be placed in any corner near the engine, and would furnish light with very little trouble. It is not, therefore, a matter of much surprise that a demand quickly arose for these machines, and that they were disposed of as fast as they could be manufactured. In spite of the proverb, M. Gramme found himself honoured in his own country, and it is probable that many hundreds of his machines were in actual use in different parts of France before one of them found its way to England. This one, we may mention as a matter of historical interest, was employed to cast a beam of light from the summit of the clock-tower at Westminster.

The success of the Gramme machine had the natural consequence of such successes—it drew the attention of electricians to the possibility of improving upon it. There seemed to be a brilliant future for anything of the kind, and inventors worked hard to realise their hopes. The first rival of the Gramme machine was that of Siemens (illustrated in Fig. 1), whose armature long ago had, as already explained, marked a stepping-stone in the history of these machines. This rival of the Gramme, however, did not employ the celebrated armature, but a modification of it, to be presently described.

The machine itself is singularly compact, as may be judged from our illustration. As a matter of fact, one which will furnish a current giving a light of 1,200 candle-power can be packed in a box measuring two feet square and one foot deep.

The arrangement of the machine will be readily understood by reference to the cut. Four flat electro - magnets are so fixed on a strong iron frame that the upper pair have their N poles facing one another, and the under pair have their S poles so placed. The poles of each pair are united by arched pieces of iron, which form together a hollow in which the armature rotates.

In the original Siemens armature (see page 165) there were in its revolution two dead points, so to speak, at which no current passed. Of course in actual practice the revolutions were so quick that this was hardly noticeable, but it represented an inequality which might be remedied by more studied arrangement of the armature wire. This was done in the machine now under consideration. The core of the armature is a hollow iron cylinder; and the wire coils, instead of being wound shuttle - like parallel to one plane, are so placed that that plane gradually revolves. So that, although there are eight distinct coils, they are not wound upon the core in one plane, but in such a manner that each convolution differs slightly in direction from that which has been wound before it. The commutator is a tube split into eight parts, which communicate with each other through the coils, and from which the current is drawn off by brushes, as in the case of other machines. The Siemens machine has now for some years been employed at the Lizard (Cornwall), to furnish the double light on that important headland, and has also come into general use in a variety of ways.

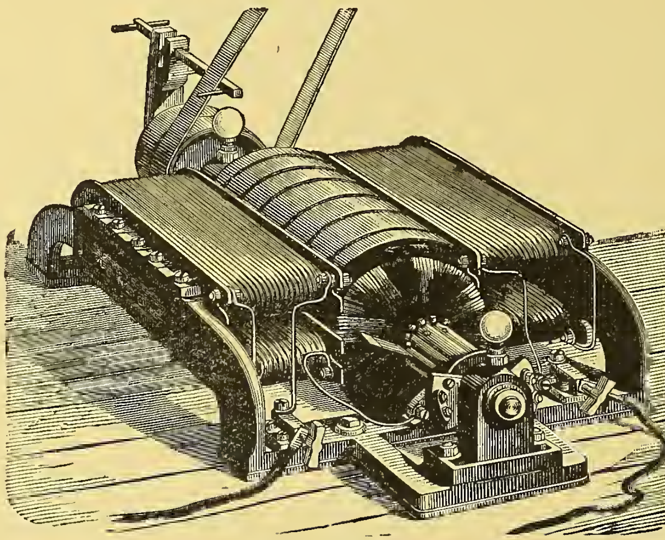


Fig. 1.—SIEMENS' DYNAMO MACHINE.

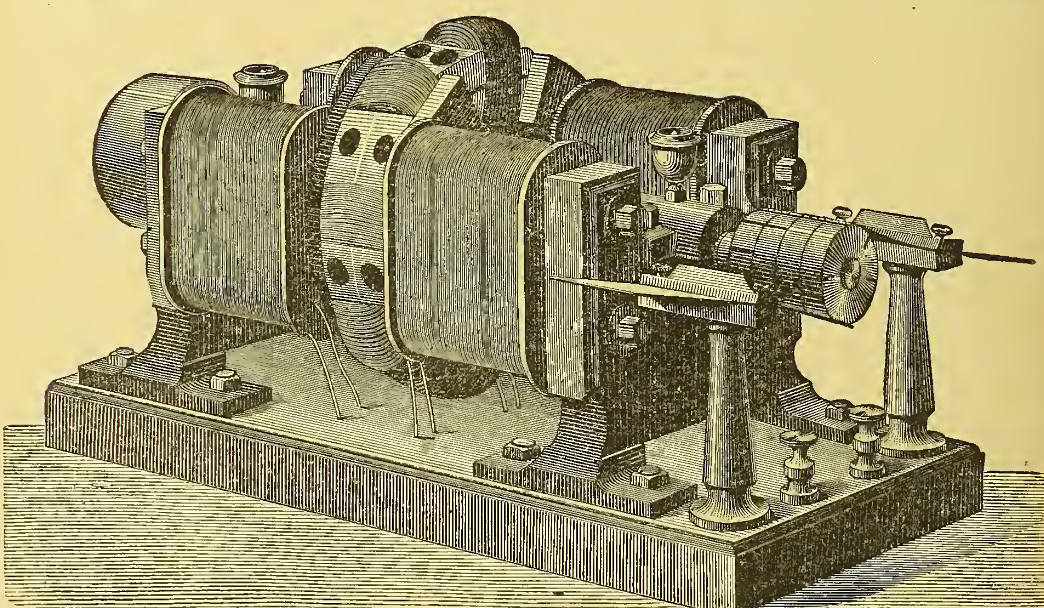
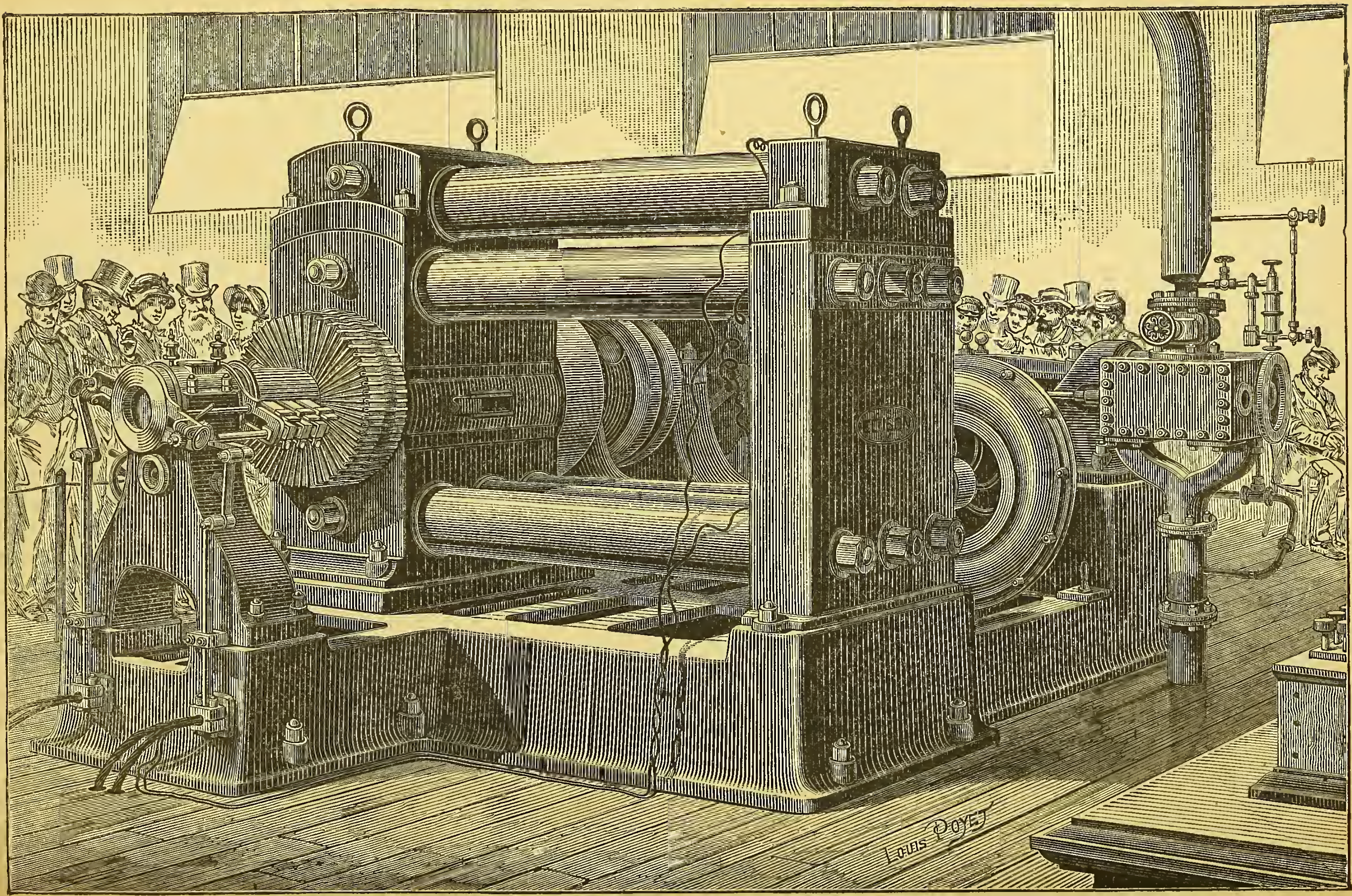


Fig. 2. THE BRUSH MACHINE.



EDISON'S GREAT DYNAMO-ELECTRIC MACHINE AT THE PARIS ELECTRICAL EXHIBITION OF 1881.

Next in order must be mentioned the dynamo machine invented by Mr. F. C. Brush (Fig. 2). In the Brush machine we find a modification of the Gramme ring. This ring is made of cast-iron, deeply grooved, to save weight and admit cool air, and with eight discontinuous coils wound upon it, in spaces cut away for their reception (see Fig. 3). These coils are connected in a different manner from those of the Gramme machine: that is to say, instead of being connected successively, opposite coils are connected. The inventor claims by this arrangement, and by the position of the field magnets, to produce, from a given amount of power, a larger available current than can be obtained by any other means. It is certain that the Brush machine is most extensively employed both in this country and in America, one of its chief recommendations being that several powerful lights can be served by one machine.

A further modification of the Gramme ring is found in another machine — that of Bürgin, which has been introduced recently, and is manufactured in England by Crompton—forming the foundation of Crompton's system of electric lighting. The ring here is no longer single, but is composed of several individual rings mounted on the same spindle. The winding on each ring is discontinuous, a space of bare iron being left between each coil. These bare places as they pass the poles of the magnets cause intense magnetisation of the ring, besides which they afford such ready access of air-currents that the machine has no tendency to get unduly heated.

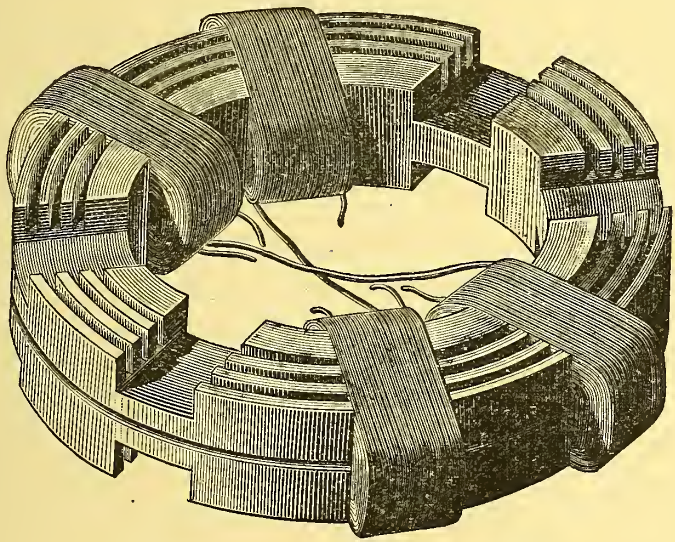


Fig. 3.—RING ARMATURE OF THE BRUSH MACHINE.

The largest dynamo machine hitherto constructed is that of Edison, in which the magnets alone weigh several tons. The general size of this gigantic machine can be understood from our full-page engraving of the one shown at the Paris Electrical Exhibition. Here we have no Gramme ring, but a peculiar modification of the armature in Siemens' machine—an armature four feet long and two feet in diameter. Its coils are not of wire, but are formed partly of half-inch bars and partly of discs, which serve to connect opposite bars together—the current first traversing a bar, then a disc, to an opposite bar, crossing a disc again, and so on. These discs, insulated from one another by plates of mica, form two solid cylinders at either end of the armature; the hollow space between them forming the core, by being fitted in with innumerable discs of very thin iron, each being separated from its fellow by silk. The object of this latter arrangement is to promote rapid magnetisation and demagnetisation. In the Gramme ring this is attained by using a bundle of wires instead of one solid core. In the induction-coil the same end is attained by the same means. The thinner the iron the more rapidly can it be magnetised, and the more rapidly can that state be again destroyed. Another advantage gained by cutting up a core in this way is that iron — a natural conductor of electricity —has, when moved in a magnetic field, currents generated in it which are not wanted, because they interfere with the work of the machine very seriously: they consume power in their production, and give out this power as heat. Now, by partitioning off the iron core into different segments, the tendency to generate currents on its own account is stopped. This machine may be said to be still on its trial, for it has been but recently introduced; but the name of Edison — who is looked upon by the American public as a magician—is sure to get it attentive consideration where electric energy is required.

Another very large dynamo machine has been constructed by Mr. Gordon, Secretary of the British Association for the Advancement of Science. Its main object is to reduce the high speed of revolution which has hitherto been deemed necessary in order to secure rapid magnetisation and demagnetisation in the armatures. By placing numerous armatures round a circle of several yards diameter, Mr. Gordon secures this with a very moderate speed of axial revolution; and the principle will probably be applied in cases where large quantities of current are required. The last important modification introduced has been in a machine patented by Mr. Ferranti and Sir William Thomson, in which the armatures consist of copper ribbons instead of wires, and contain no iron cores, thereby saving much weight and cost.

Having thus briefly described the old magneto-electric machines, and the principal dynamo machines which followed upon them, and which are now competing for public favour, it remains to be considered for what purposes these remarkable contrivances can be employed. We have most of us had optical proof that they will furnish a brilliant light, but this application of the electric current will form the subject of future treatment. An equally important application of them is the possibility of transmitting energy from place to place by their aid.

To understand how this can be done, we must first recognise the fact that the dynamo machine will not only give a current when its armature is rotated, but that if a current be sent through it from some independent source, its armature will be caused to rapidly revolve. Thus, supposing that we attach to the terminals of a hand Gramme machine, such as is made for lecture-table demonstration, the terminal wires from a battery of thirty or forty Bunsen cells, the handle of the machine is violently rotated by invisible means. It need hardly be pointed out that in the same way the current from one dynamo machine can be used to turn another into an electro-motor. The late Professor Clerk Maxwell is said to have given it as his opinion that this reversal of the Gramme machine was one of the greatest discoveries of the age. He, of course, alluded to the anticipations that such a discovery was likely to arouse. The possibility of thus conveying energy from place to place by means of stationary wires opens up a vast field of labour, if the work can be done economically; but like most questions which affect vast commercial changes, this one is dependent upon the three letters £ s. d.

Mr. C. W. Siemens, the inventor of the Siemens machine already described, was, we believe, the first to point out what a wonderful aid to progress this transmisson of power by electricity might become. Four years ago, at a lecture in Glasgow given by him "On the Utilisation of Heat and other Natural Forces," he pointed out how much force is allowed to run to waste at the Falls of Niagara; 100,000,000 tons of water fall there every hour from a height of 150 feet. This represents an expenditure of 16,800,000 horse-power, the only result produced being a slight elevation of the temperature of the water at the foot of the fall. By the aid of turbines, or water-wheels, this force, or some portion of it, might be made to actuate dynamo machines, and by means of metallic conductors the electricity thus obtained could be made to give motion to other dynamo machines at a distant spot. We already know that these machines will carry energy for the electric light to considerable distances, and such energy could be turned into motion as easily as into light.

Dr. Siemens, on the same occasion, pointed out that in this country, although we have no Niagara, there are many places where water-power is allowed to run to waste. This is especially the case in Scotland, with its elevated lands and heavy rainfall. Other scientific men maintain that the tides might even be enlisted in the service of actuating these machines, but they do not point out a practical method of accomplishing it. Even windmills may be used indirectly. They certainly represent a somewhat uncertain form of power, but Dr. Siemens suggests that they might be employed in raising water to high reservoirs, which might afterwards be utilised by the help of turbines and dynamo machines.

Another ingenious application of the dynamo machine is for agricultural purposes. Dwellers in country places know well enough how the steam-engine has invaded the corn-fields. The old-fashioned reaper and haymaker have given place to machinery which cuts, reaps, and binds into sheaves automatically. Even the plough is now worked by a stationary steam-engine, which, by means of wire ropes, hauls the ploughshare through the soil. It is to this latter purpose that the dynamo may be applied, the drums upon which the wire ropes are wound being actuated by electricity instead of by steam. The new motor has also been lately experimentally applied to gathering in the long lengths of cloth from the bleaching grounds, a steam-engine being inadmissible here, by reason of its grimy belongings.

In transforming electrical into mechanical energy, there is, of course, some loss, owing to friction, heating of wires, &c., but Dr. Siemens maintains that in a properly-constructed machine this loss need not exceed ten per cent. Then there is a similar loss in once more turning the current into mechanical effect, and a further loss by reason of resistance offered by the conductors or wires. Altogether, we must consider that in this form of transmission of energy, the loss at present amounts to nearly one-half. With regard to its advantages, we must look to the small space occupied by a powerful dynamo machine, and its absence of dirt and waste products; but as we before pointed out, its general adoption will depend upon the price at which its labour can be employed. In another article we will describe what has actually been accomplished in the actual application of electricity as a motive power.

MAN-EATING TIGERS IN INDIA.

ENGLISH engineers have now laid down some thousands of miles of railway in Hindustan, and have thus helped to bring its inhabitants into closer relationship with those who govern them. But the country is of such vast extent, that many years must necessarily elapse before millions of the natives can be influenced by such civilisation as we can offer them. There are still innumerable detached villages in the wildest parts of India where the rude dwellings of the natives are surrounded by tangled jungle and fever-breeding swamp. But fever is, unfortunately, not the only danger to which the people are subject. According to the annual report published by the Indian Government, a vast number fall victims to snake-bite and the depredations of wild beasts. The best endeavours have been made to remedy this fearful state of things, and that the precautions taken have proved successful is evidenced by the steady decrease in the number of deaths from such causes which are recorded year by year. Still the loss is awful, amounting as it has in a single year to twenty thousand lives! Unhappily we may feel certain that the official returns do not comprehend all the casualties, for it is obvious that many deaths must occur in out-of-the-way regions which are never known to the outside world.

Although poisonous snakes are credited with by far the greater number of these deaths, the man-eating tiger is still a terrible reality which claims a number of victims every year, and is far more feared by the villagers than any number of venomous reptiles. The man-eating tiger is fortunately not commonly met with, and we are thankful to think that, owing to the way in which he is hunted down, he is getting scarcer every day. The ordinary tiger is common enough, but he is not formidable unless provoked; for like most other creatures, he is cowed by the approach of man, and will slink out of the way rather than attack him. But once let the tiger taste human flesh and, so it is believed, he will never afterwards care for other food. He has been known to prowl for weeks in the neighbourhood of a lonely village, stealing out from his hiding-place from time to time to pounce upon some man or woman working in the fields, or to carry off a child which may have wandered a few yards from home. In vain the poor villagers bar their houses at night, and take care to wander not far away, until fancied security tempts them to imagine that the danger is past, and that the destroyer has sought fresh pastures. Another victim seized plainly tells them that their enemy is still near them, and in despair they leave the village in a body, carrying with them such goods as they can carry, to find a fresh abiding-place. Their crops they leave to rot in the fields as they stand—they are homeless outcasts. The position of these poor creatures is the more pitiable from the fact that they are defenceless. Ever since the Indian Mutiny they have been forbidden to carry arms, but by special permission a license can be obtained by perhaps one or two head men to possess antiquated fowling-pieces. These obsolete weapons are of about the same value as pop-guns; they serve to frighten birds away, but are good for nothing else.

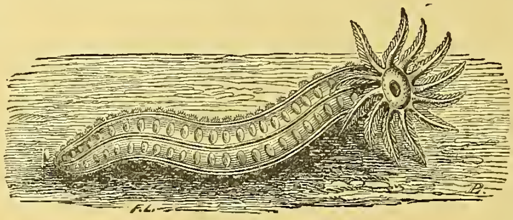
Of course there are many districts where the people are in a much better position, having in their midst some sportsman, or local officer, who will soon take measures to destroy any man-eating tiger which comes into the neighbourhood. The creature is full of cunning, but is generally such a coward that he can, when found, be easily despatched. The sportsman greatly prizes the tiger's skin, which, however, has not always an intrinsic value; for often it is poor in quality, and sometimes absolutely mangy. But the courageous hunter values it for its own sake, as a soldier prizes his hardly-earned medal. It serves to remind him of an exciting and dangerous episode in his career, and it is the witness of a great service rendered to his fellow-creatures.

AN INGENIOUS STRATAGEM.

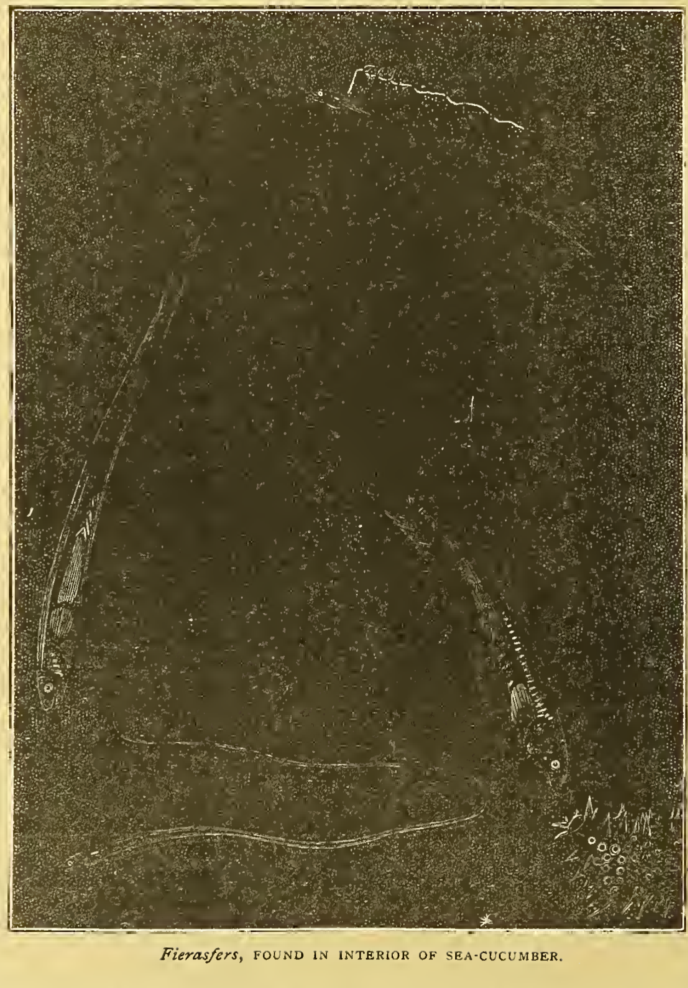
THE accidents to which physicians of eminence have owed their prosperity are in many cases exceedingly curious, and many have found it necessary to resort to a species of quackery and imposture to give publicity to their actual ability. In this way the famous physician Portal commenced his career of success. Having been long in Paris without patients, and observing with bitterness that fashion, rather than scientific acquirements and sound practice, made the fortunes of his most prosperous rivals, he at last determined upon a bold stroke, and spent every coin he had in the purchase of a very handsome equipage, which appeared day after day as if waiting for him outside the doors of people of the highest rank and fashion, especially such as he knew to be sick or ailing. Curiosity being aroused, inquiries were made as to who was the owner of this *imposing* equipage, and the doctor took care that such curiosity should be promptly gratified. The result was that the marchioness determined to have the physician of the duchess, and the commoner became anxious to secure the physician of the lord; so that in a short time Portal received invitations to give advice in far more cases than he could possibly attend. His talent, handsome person, and elegant manners did the rest. He achieved a fortune almost as great as his reputation, and of all the physicians in Paris was the most fashionable.

ANIMAL COMPANIONSHIPS.

AMONGST the many curious phases of animal-life, none are more striking than those which deal with the phases of what may be called animal friendships and associations. It is a notable fact of natural history that in certain cases animals which do not appear to possess the slightest relationship with one another in any normal or ordinary sense may, nevertheless, present evidence of association of the most fixed and constant character. That there are various phases of this association between living beings is evident from the most cursory view of the subject. For example, there is a companionship amongst animals the reverse of friendly, and which is named *parasitism.* One animal lives in or upon another animal, living as a "guest" at the expense of the latter, which acts as its "host." Thus, a tape-worm dwelling in the digestive system of another animal offers an instance of this "parasitic" friendship; and the "fluke"-worm, which infests the liver of sheep, and causes the disease known as the "rot" in that animal, also illustrates this form of association. In parasitism we see how an animal gains an easy livelihood by subsisting on the gains and work of another form. There is a curious history attached to associations of this kind, for we discover that many parasites, although rooted, fixed, and destitute of eyes, sense-organs, and legs when adult, are free-swimming, and possess sense-organs and legs when young. This fact alone seems to show us that these fixed parasites were originally as free-living as their hosts, and that they have adopted the lower life of the parasite as a secondary and acquired feature of their existence.



SEA-CUCUMBER.

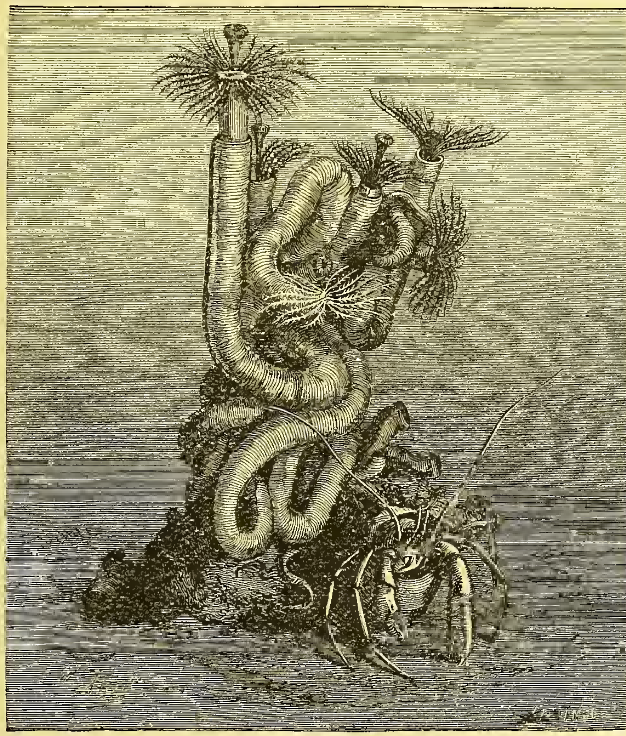


Fierasfers, FOUND IN INTERIOR OF SEA-CUCUMBER.

But far more curious are those cases of association in which apparently no advantage accrues from the companionship. Take as an example of this latter phase of animal-life, the association of certain small corals found in tropical seas, each of which gives shelter to a worm. The coral is never found without its worm-tenant; and as there are many species of the coral in question, the constancy of the association is one of its most remarkable features. One result of the association of the coral and the worm appears to consist in the modification of the coral itself. Its growth is affected somewhat by the presence of its worm-tenant, and peculiarities in shape are induced thereby. No group of animals afford more frequent and constant shelter to other forms than the sponges.

Within these organisms a whole host of animals are constantly found. For example, certain worms are guests of the sponges, and crabs, shell-fish, and even small fishes, may be found in constant association with the sponge group.

The sea-cucumbers, or *Holothurians*, are near relations to the star-fishes and sea-urchins. An ordinary sea-cucumber in shape is not unlike the familiar vegetable from which it derives its name. It possesses an elongated body, and a mouth surrounded by a circle of feathery tentacles. One of the curious facts of sea-cucumber existence consists in these animals giving lodgment to other forms, which have therefore been called "messmates." It is interesting to note that certain small fishes appear actually to live in the inside of the sea-cucumber's body, and to swim in and out of that body at will. Fishes known as *Fierasfers* thus live in the interior of tropical sea - cucumbers, and appear, in some way not quite determined, to benefit from the association. The fishes in this way, at least, avail themselves of welcome shelter, and possibly also obtain food-particles from the sea-cucumber's own digestive system.



TUBE-WORMS ON SHELL OF HERMIT-CRAB.

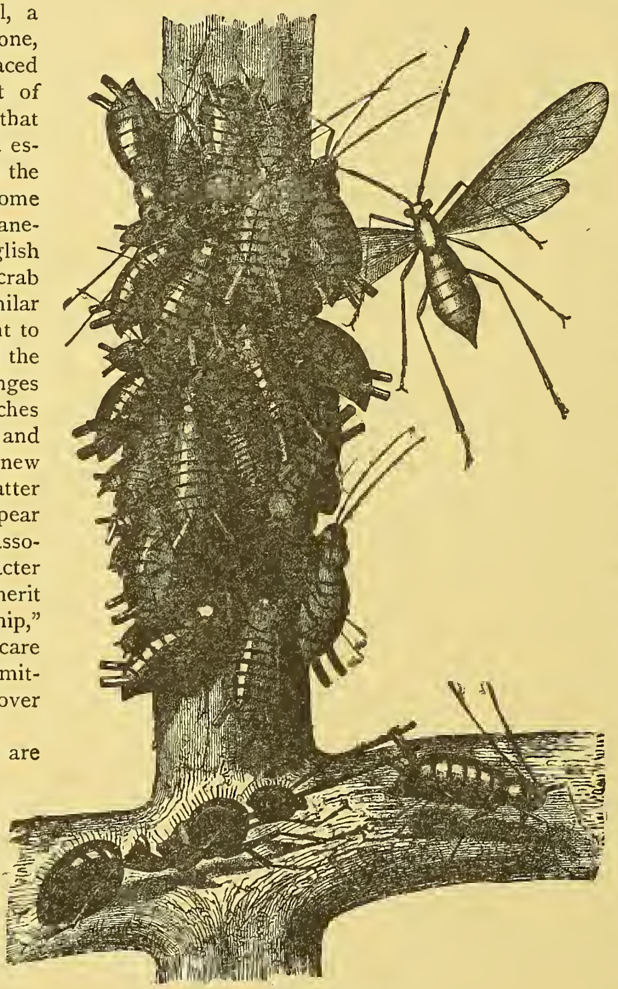
More wonderful still is the companionship of fishes with sea-anemones. Every one knows that the sea-anemones possess cylindrical bodies, attached by one extremity to a rock, and having a mouth surrounded by tentacles, or feelers, at the other extremity. When a crab or other animal stumbles against the outspread tentacles of an anemone, it is at once seized, and dragged into the mouth and stomach-sac of the latter. In this way the anemone procures its food; and its sensitiveness is, of course, the means whereby it is enabled to seize its prey. The puzzle of the anemone association with fishes is therefore extremely complex, because with the sensibility of the anemone to outward touch, the mere presence of the fish, it might be thought, would serve to cause contraction of the host's body, and consequent ingestion of the fish. But that the friendship is of the most fixed character is evident from the observations of naturalists. The fishes have been seen to swim in and out of the mouth of the anemones, and the latter have also been observed to close around the fishes, and, as has been remarked, to practically enfold the fish in a living tomb, unclosing again, and permitting the exit of the fish. In the same way a fish has been seen to inhabit a species of tropical star-fish.

The "Portuguese man-of-war," or *Physalia*, has been already noted (page 161) for its stinging powers. Very curious, therefore, is it to discover that certain fishes allied to the mackerel group seem to live in constant association with the jelly-fish, whose tentacles literally bristle with stinging weapons of the most terrific character. Some of the jelly-fishes, which are common in British seas, have been ascertained to act the part of "hosts" to fishes. One fish (*Caranx*) lives associated with a beautiful jelly-fish (*Chrysaora isocela*), and appears to be on the happiest of terms with its strange companion. The mussels, those most familiar of shell-fish, and their neighbours give shelter and food to certain small crabs, named "pea-crabs." Pliny of old speculated on the utility of the crab, which he supposed served to warn the mollusc of danger. But this theory is, of course, utterly untenable, and the crab lives in the interior of the mussel-shell simply in virtue of the same "law of association" through which other and as varied animals are united in zoological companionship. There is no doubt that the crab will devour the food-particles which may be swept into the mussel-shell by the currents of water which are continually passing to and from the animal, and which are wafted into the gills of the mussel for purposes of breathing.

Probably one of the best-known cases of animal association is that which exists between a species of hermit-crab—dwelling in the cast-off shell of the whelk—and a sea-anemone; whilst installed within the shell of other hermit-crabs certain worms are invariably found. Thus, a Mediterranean hermit-crab possesses, adherent to its shell, a species of anemone, whose mouth is placed just opposite that of the crustacean, so that the morsels which escape the claws of the hermit-crab become available for the anemone. An English species of hermit-crab possesses a similar messmate adherent to its shell, and when the hermit-crab changes its shell, it detaches the anemone, and shifts it to its new abode. This latter feature would appear to show that the association is of a character which seems to merit the term "friendship," in respect of the care which the hermit-crab exercises over its "guest."

Hermit-crabs are also often found, as depicted in the illustration, bearing an immense load of tube-worms, which have grown so enormously since the crab took possession of the shell, as to constitute a considerable burden. Though no direct mutual benefit has been traced in this case, it is difficult to suppose the crab would not change his shell for one less weighted unless there were some benefit from the companionship.

Amongst the insect hosts there occur certain examples of very remarkable associations. Best known of these are the friendships of ants and the aphides, or "plant-lice," so common in all our flowers and shrubs. The plant-lice secrete a sweet fluid, of which ants are very fond, and by stroking the backs of the plant-lice with their "feelers," the ants cause them to emit the honey secretion. The operation is shown in the illustration. The nature of the secretion is not positively known, some considering it to be of the nature of excrement, while others believe it to be rather a surplus of products secreted by the aphides for their own benefit. But in any case it is most remarkable that whole races of ants should have discovered the possibility of making the aphides yield more of the exudation by an operation as strictly artificial as the milking of a cow; and that certain colonies should regard the insects on certain plants as their own property, and resolutely drive off all invaders. Nay more: it is now well established by the researches of Sir John Lubbock and others, that many ants actually keep plant-lice quite away from their natural food, as we keep cattle in stalls, bringing them food, tending them, and, of course, "milking" them sedulously.



ANTS AND PLANT-LICE.

Also found in the nests of ants are certain species of beetles. Over 584 species of insects are known to live in association with ants, and of these 542 are beetles. One kind of these beetle friends of the ants (*Claviger*) is blind, these beetles being actually dependent on the ants for food. A claviger beetle seems actually to have lost the power of feeding itself, and it is fed by the ants, just as these insects feed one another. The remarkable fact has also been noted that if one of these beetles be transferred from the nest of the particular ant species which harbours its kind to the abode of another species of ant, the beetles will be attacked and eaten by the stranger ants. M. Lespes, who has made these beetles and their ant friends a special study, infers from this fact that the intelligence of the ant races is not equal throughout, and that those species of ants which harbour the beetles are more advanced in intelligence than the species who do not entertain beetle guests. The precise benefit from this companionship remains to be ascertained; but from the value set upon it by the ants it is almost impossible not to suppose that some is derived, as in the case of the aphides.

As a final feature in these curious histories, it may be remarked that the companionship, which begins as a mere association, may in animals become better developed, and initiate the condition of parasitism itself. The accidental association, if of benefit to the animal which ranks as the "guest," may become of closer nature. From being simply a "lodger," like the pea-crab inside the mussel, the "guest" may become more and more dependent upon the "host," and may in time exhibit a complete dependence on the latter. It is probably in this way that the parasites of to-day originally began their altered existence. One proof of the correctness of these deductions is seen in the fact that there exist in nature all stages, leading from the pure and simple association to the condition in which the parasite, degraded and lowered in the scale, has become permanently attached to its "host."

EPICUREAN WONDERS.

THE Count du Broussin boasted that he never passed a day without adding something new to his gastronomical knowledge; and that he could so disguise the natural taste of fish, flesh, or fowl that no one could distinguish one from the other. He devoted the whole of his time to gastronomical experiments, and when he had discovered a new dish or a new sauce he invited all the great epicurean celebrities within his reach to meet at his table, where it was as solemnly tested and as learnedly criticised as if it had been the last production of a great poet. Amongst those whose judgment he most anxiously consulted were the Duke de Lesdignières and Count d'Olonne. On the day of such a *repas d'érudition*, he always arose at four o'clock in the morning to join his cooks, and, although a good-natured man, should the *chef garçon de cuisine* or any of his assistants appear neglectful or inattentive his rage was like that of a madman. The pillory and loss of ears were then amongst the mildest of punishments threatened. He believed that the flavour and delicacy of his dishes were so subtle that even if the surface they rested upon was not mathematically horizontal they would be affected. He held that mushrooms were best after they had been crushed by the foot of a mule, and declared that he could distinctly recognise the flavour they received after being so crushed.

Not less wonderful an epicurean was John Hay, Earl of Carlisle, who lived in the time of James the First, and was called "The Scottish Heliogabalus." It was said of the dinners he gave, that by keeping envoys and plenipotentiaries in good humour, he did more for maintaining the peace of Europe than all the diplomatists of his day put together could accomplish. One of his contemporaries says he won the royal favour and friendship by giving the king "a most strange and costly feast," which other contemporary historians also speak of. It is also asserted that the jealous dislike with which the English nobility regarded the Scotch was softened and subdued by the influence of feasts prepared by the Earl for bringing them together. King James made him first Lord Hay, then a gentleman of the bedchamber, and then he procured him a rich wife in the person of Lord Dennys' sole daughter and heiress. He received a grant of the island of Barbadoes, was made a Knight of the Garter, and was created successively a baron, Viscount Doncaster, and finally Earl of Carlisle. His second wife was the Earl of Northumberland's daughter. With every fresh accession to his wealth and dignity the rarity and costliness of his great feasts increased. Osborne, one of his contemporaries, speaks of little tarts made, amongst other things, with "ambergrease, magisterial of pearl, and musk," each of which tarts cost the then enormous sum of ten pounds. When this epicurean earl travelled, he carried with him a little army of cooks, and sent couriers in advance to make preparations for them, converting every roadside inn into a temple of choice and costly gastronomy. Clarendon wrote of him, "He was surely a man of the greatest expense in his own person of any in the age he lived in; and introduced more of that expense in the excess of clothes and diet than any other man, and was indeed the original of all those inventions from which others did but transcribe copies." For thirty-two years, *i.e.*, from 1604 to 1636, his life must have been one continuous feast; and in the year last named he died, tranquil and resigned, like a man who had fulfilled a goodly mission.

That Admirable Crichton of the kitchen, M. de Carême, who was *chef de cuisine* of the Baron de Rothschild, was the descendant of the famous French *chef* who, under Pope Leo X., received the brevet of immortality for a *soup maigre* which gave him his surname Jean de Carême, or Jack of the Lent; which name his descendant bequeathed to the not less famous *sauce*, which bears it still. His fame spread fast, and at last all the sovereigns in Europe were in eager rivalry to secure his services. One of the highest bidders was the Emperor of Russia, but he gave the preference to our English monarch, George IV., who was, however, then but Regent. But the great man soon relinquished his post on the plea that Carlton House was a *ménage bourgeois* unworthy his great reputation; and, at a salary far beyond any a mere sovereign could offer, he devoted his art to the service of M. le Baron Rothschild. It was said that immense sums were offered for his second-hand *pâtés* after they had been taken from the table of the Regent. A contemporary describing one of his dinners, said, "With less genius than went to the composition of this dinner men have written epic poems; and if crowns were distributed to cooks as to actors, the wreath of Pasta or Sontag, divine as they are, were never more fairly won than the laurel which should have graced the brow of Carême." The same author, speaking of the eminent *chef* himself, says, "He was a well-bred gentleman, perfectly free from pedantry, and when we had mutually complimented each other on our respective works, he bowed himself out and got into his carriage, which was waiting to take him to Paris."

Amongst other deifiers of the palate whose extraordinary doings give them a right to be placed amongst wonders, stands one named Rogerson, whom Meg Dodd in her amusing book on cookery calls "a martyr." He was a native of Gloucestershire; received his education at one of the universities, made "the Grand Tour" after the fashion of his day, and concentrated the whole of his attention upon gastronomical art. His father's death placed a large fortune in his possession, and he devoted it to the palate; keeping no one in his house who was not an accomplished cook: butler, footman, housekeeper, coachmen, grooms, all were cooks; while for cooks proper, he had three whom he brought from Italy—each a famous one—one who came from Florence, another from Sienna, and a third from Viterbo, whose duty was confined to the preparing of one special dish, the *dolce piccante* of Florence. He had a messenger constantly on the road between Brittany and London to bring him the eggs of a particular kind of plover found near St. Malo. It is recorded that one dinner which was prepared exclusively for himself, and consisted of but two dishes, cost fifty-eight pounds. In nine years he dissipated his fortune of £150,000, and was found starving by one of his friends, who gave him a guinea; and going soon after to the wretched garret in which the ruined epicure had found refuge, discovered him roasting an ortolan! A few days afterwards he shot himself.

THE MAGIC MIRRORS OF JAPAN.

THE Japanese have long been famous for their curious metal-work, and many a first-rate English workman would be puzzled to state how some of the inlaying peculiar to Japanese work is accomplished. Among the curious productions of this kind must be numbered the so-called magic mirrors. At first sight these mirrors seem to have nothing peculiar about them. Composed of a mixture of lead, tin, and copper, in certain proportions, they exhibit at one side a brilliantly polished surface, rather convex, while the reverse (see Fig. 1), or back of the mirror, is ornamented with those fantastic, but artistic representations of natural objects which we are accustomed to in anything of Japanese origin. Minute examination of the polished surface, even with a strong magnifier, will detect no flaw or break in its even texture. But strange to say, if the mirror be used to reflect a beam of light on to a flat surface, such as a white wall, the pattern at the back is rendered distinctly visible in the projected image. Hence the Chinese call these mirrors by a name which signifies "Mirror which lets the light through."

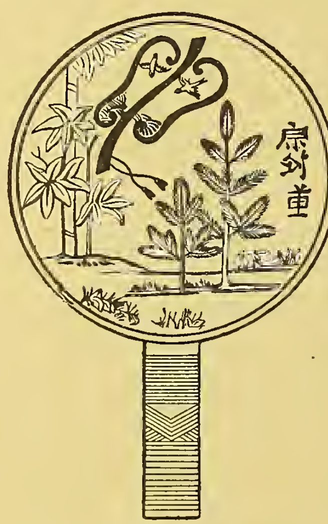


Fig. 1.—JAPANESE MAGIC MIRROR.

There has always been a great deal of mystery attached to this curious mirror, and many scientific men have at different times endeavoured to explain the cause of the phenomenon which it exhibits. Some have thought that the pattern is stamped upon the back, and that therefore the metallic particles, where heavy pressure has been applied, have assumed a molecular change which penetrated to the other side, although that change is not visible until the light is reflected from it in the way already described. It is quite certain that, whatever the makers may pretend, the Japanese themselves are *not aware* of the cause of the phenomenon; and that the strange property is conferred upon the mirrors by an *accident* of manufacture. It is accordingly found that all Japanese mirrors do not act in the same way, some refusing to show any pattern whatever.

That the reflected image is not due to any stamping process is proved by a description of the way in which the mirrors are made, which was read some time back before the Asiatic Society of Japan. From this account we gather that the metallic alloy is melted in a crucible, and is afterwards poured into a mould made in two halves put together—a mould made of dried clay and placed in wooden frames such as a brassfounder would use in this country. When the metal is cooled, the moulds are broken up, and the rough casting is scoured and filed into shape. The reflecting surface is then carefully polished, and receives an amalgam of quicksilver, tin, and lead, which is rubbed in with leather until it becomes as bright as a looking-glass. Before this amalgam is applied, the surface is worked into shape by the application of an instrument called a *megebo*, or distorting-rod.

A great many ingenious theories were advanced by scientific men to account for the mysterious reflections of the Japanese mirror, when that curiosity was first imported to this country. But like a nine days' wonder, it was dismissed to oblivion, when each one had to his own satisfaction given a learned opinion upon the matter, till the subject was renewed two or three years back, and the problem finally solved in a paper read before the Royal Society by Professors Ayrton and Perry. The mirror was on this occasion once more produced, and its reflected pattern was projected on a screen, as shown in the cut, by means of the oxy-hydrogen light. From that paper we quote the following explanation of the phenomenon :—

"The magic of the Eastern mirror arises, not as has been supposed from a subtle trick on the part of the maker, nor from inlaying of other metals, nor from hardening of portions by stamping, but from the natural property possessed by certain thin bronze, of buckling under a bending stress, so as to remain strained in the opposite direction after the stress is removed. And this stress is applied by the *megebo*, or distorting-rod, and partly by the subsequent polishing, which, in an exactly similar way, tends to make the thinner parts more convex than the thicker."

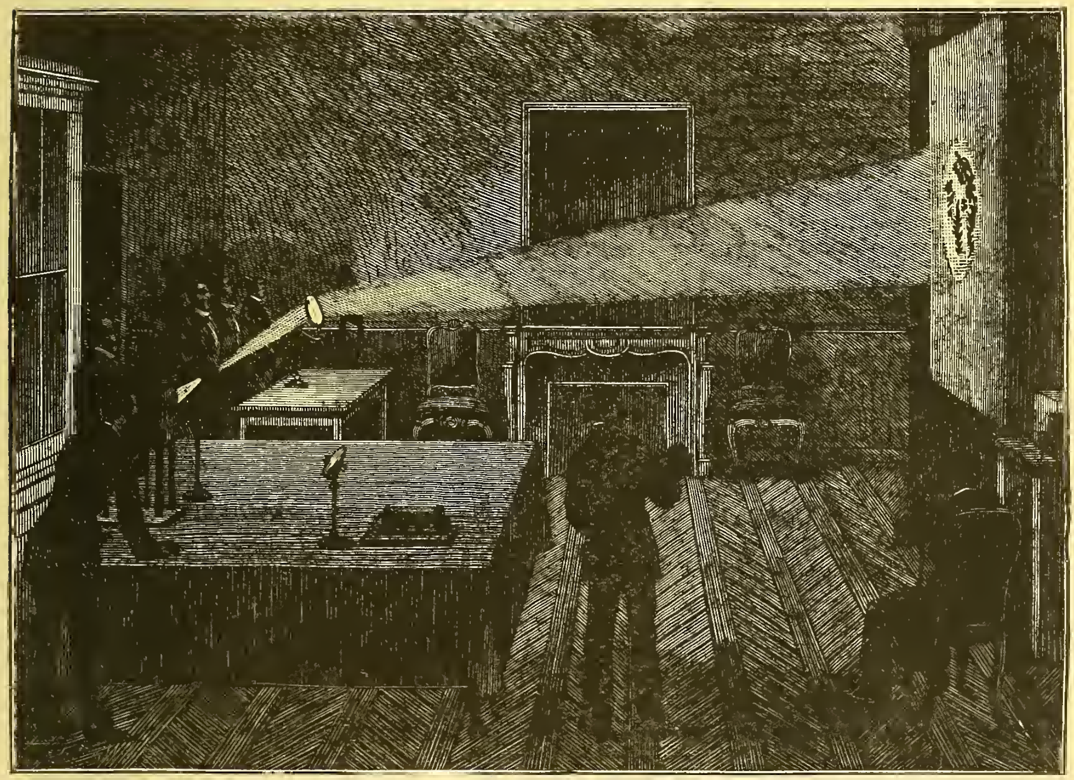


FIG. 2.—PATTERN PROJECTED BY THE OXY-HYDROGEN LIGHT FROM A MAGIC MIRROR.

The magic mirror in Japan has a mystic significance which places it far above an ordinary looking-glass in the popular estimation. Indeed, it is looked upon with the reverence that Europeans would attach to a religious symbol. It forms an important part of the regalia of Japanese sovereigns; any one of whom would consider his feelings outraged if told that its wonderful powers were due to "thin bronze buckling under a bending stress."

REMARKABLE DISCOVERIES OF CRIME.

In a previous article (p. 167) we have mentioned some extraordinary cases, well authenticated, in which crimes have been brought to light by dreams. There are many other cases on record, in which crime apparently hidden, and sometimes long hidden, with success, has been discovered in very remarkable ways. A few such cases we propose to describe in the present article.

WILLIAM BEGBIE OF LEITH.

William Begbie was a porter at a bank in a street of Old Edinburgh, called the Netherbow, in the year 1806, when on the 30th of November he was sent out with a bundle of notes to the value of more than £4,000. There was a long, narrow, dark passage, leading from the bank to the street, and there he was stabbed to the heart and the notes stolen. The knife was left in the body. It was one of the kind used for cutting bread, with a long thin blade, with a newly-made sharp point, and a wooden handle which had been thickly covered with paper to preserve, as it seemed, the hands and clothes of the murderer from being blood-stained.

Although large rewards were offered, with a pardon for the murderer's accomplices, and a thoroughly exhaustive search instigated throughout the city, no single suspicious house remaining unvisited, not a clue to the perpetrator of this awful crime could be discovered.

At last, after a number of evil characters had been taken up, examined and discharged, a carrier between Edinburgh and Perth was arrested. He was a strong powerful fellow, known as a desperate, dangerous evil-doer, irregular and dissolute in his habits, and he had been seen near the Canongate, which was close to the scene of the murder, about the hour of its committal. After some long time he was discharged, no evidence justifying his detention being forthcoming.

On August 10, 1807, a journeyman mason and two of his companions found in the Bellevue grounds near Edinburgh a hole in a stone enclosure, concealed by a hedge and accidentally revealed, and in it a parcel of bank-notes which had evidently been there a long time. These were the missing notes, and the men were rewarded with £200 for their honesty.

In 1822 a well-known Bow Street officer named Denovan discovered in Leith a man who told him that on the morning of the murder he was a sailor lad, and that coming ashore he saw a man like William Begbie, followed by a genteelly-dressed man in black. He lost sight of them, but when he was opposite the narrow passage spoken of above, he saw the man in black running out of it with something under his arm. He heard of the murder on the following day, but the mate refused him permission to come ashore, and in a few days he sailed for Leith, was captured by a French privateer, and did not regain his liberty before the war was over. The description of the man in black corresponded exactly with that of James Mackoul, a London criminal of great daring and ingenuity, who resided in Edinburgh at the time of, and close by, the scene of the murder, which he could reach swiftly and secretly. When Mackoul was under sentence of death for a robbery committed in 1820, Denovan mentioned this fact to him, upon which. in a paroxysm of terror, he vehemently denied it, and stated that about that time he won at gaming £10,000, and had no occasion to rob any one, but at the same time making other statements which left little doubt that at last the murderer of poor Begbie was actually discovered, although it was for another crime that he suffered death.

HANGED BY A GHOST.

An old volume of the *Quarterly Review* mentions a crime discovered in a most extraordinary way in Australia in the year 1830, of which a public record is preserved, and which figures with full details in the journals of that period. The confidential steward of a wealthy settler near Sydney stated that his master had suddenly been called to England on important business, and that during his absence the whole of his immense property would be in his exclusive care. Some weeks after an acquaintance of the absentee settler riding through his grounds was astonished to perceive him sitting upon a stile. He strode forward to speak, when the figure turned from him with a look of intense sorrow and walked to the edge of a pond, where it mysteriously disappeared. On the morrow he brought a number of men to the water to drag it, and the body of the man supposed to be on his way to England was brought up. The steward was arrested, brought to trial, and, frightened at the story of his master's ghost, confessed the crime, stating that he did the murder at the very stile on which his master's ghost had appeared. He was duly executed.

A GUILTY WOMAN AT THE THEATRE.

The *Gazette de France*, of November 18th, 1815, contains the account of a woman, the mother of three children, who while witnessing a play by Beaumarchais called "The Guilty Mother," in company with her husband, became strangely agitated. While the fourth act was in progress, her emotions of agony and terror were so powerful that she had to be removed and taken home, where she confessed to her husband a crime of which she had never been suspected, and of which he made no revelation until after her death, which followed within three days of her visit to the theatre.

EUGENE ARAM.

ONE of the most wonderful discoveries of crime on record was that which led to the conviction and execution of Eugene Aram, a learned man, who came of an ancient, highly respectable family, which had been reduced by time and successive misfortunes to the humblest rank. In the year 1745, and in the month of February, Daniel Clarke, a shoemaker, living at Knaresborough, in Yorkshire, who was newly married to a woman through whom it was reported he had received large sums of money, suddenly disappeared. This was accounted for by the fact that he had bought on credit plate, jewellery, watches, &c., and, being unable to pay for them, had carried out his expressed intention of going to London, where it was believed that he disposed of the dishonestly acquired property. About the same time Eugene Aram left the same neighbourhood, and went to London, where he had formerly been employed as usher in a school.

Fourteen years after, when it was supposed that Aram was dead, as nothing had been heard of him all that time, a labourer named Jones, digging for stone amongst the rocks, in a field close by Knaresborough, called St. Robert's cave, found, about two feet under the soil, a human skeleton, which, when closely examined, led to the belief that it was that of a murdered man. The disappearance of Clarke was recalled to mind, and it was also remembered that the wife of Aram, whom he had quarrelled with and separated from, might give evidence of her husband's connection with Clarke, and with another man named Richard Houseman, who, twelve months after the shoemaker's disappearance, had also left the neighbourhood. It was also known that Mrs. Aram, at the time of Clarke's disappearance, had suspected that he was murdered.

Aram and Houseman were sought for, and the latter being discovered seemed overwhelmed with terror and confusion. Being compelled to take up one of the bones, he said, with strange confidence, "This is no more Daniel Clarke's bone than it is mine," and when sternly questioned as to how he could be so sure of that, grew bewildered and terrified to such an extent that he confessed, turned king's evidence, and pointed out the spot where the body of the missing man really was buried, having been murdered by Eugene Aram. Aram was soon after discovered at a school in Norfolk, where he was usher, and there arrested.

According to Houseman's confession, on the night of February the 8th, he and Aram persuaded Clarke to go out with them for a walk. They went through the hedge into the field and towards the cave. When within six or seven yards of the cave he saw Aram in the moonlight striking at Clarke, who after receiving several blows fell. He afterwards shared with Aram the plunder taken from the body, and escaped with it into Scotland, while Aram took his share to London and disposed of it to a Jew. Aram defended himself with great power in a clear, logical, and most impressive speech, full of learning; but the jury pronounced him guilty, and he was condemned to death. Before he was executed on the 16th of August, 1759, at York, he confessed the justice of his sentence, and on the morning of his death he made a desperate attempt upon his life with a razor which he had concealed in his cell.

JAMES GREENACRE.

IN December, 1836, the mutilated remains of an old woman were found in a partially-built house, one of a row called Canterbury Villas, in the Edgeware Road. The head and limbs were missing, and the trunk was wrapped in old rags and a piece of sacking. At the inquest, a verdict of wilful murder was returned against some person or persons unknown. On the 7th of the following January, a human head was discovered in that portion of the Regent's canal which ran through what was then called Stepney Fields. The body previously found was exhumed, and the head was found to fit it. On the 2nd of the succeeding February, the limbs of the same corpse were recovered from a drain in the neighbourhood of Cold Harbour Lane, Camberwell. On the 20th of the next March, a barber named Gay, residing in Tottenham Court Road, recognised the head, which had been preserved in spirits, as that of his sister, Hannah Brown, as afterwards others who had known her did also. It was then found that this woman had been on the eve of marriage to a man named James Greenacre, to whose house in Carpenter's Buildings, Camberwell, she had gone with all the property she possessed, and with whom she had last been seen. He was taken into custody a few days after, at his lodgings in St. Alban's Street, Kennington Road, together with a woman named Sarah Gale, with whom he cohabited, and with whom he was upon the eve of emigrating to America. In the station-house he attempted to strangle himself. Some of the murdered woman's property was found in his possession, together with some rags corresponding with the pieces discovered with the mutilated remains. Bit by bit the evidence accumulated, and the trial satisfied both the jury and the public; the man and woman were both pronounced guilty. Greenacre solemnly protested that Gale was "as innocent as any lady or gentleman in this court." He was condemned to death, and she was transported for life. Before his execution he made a full confession, giving as the cause of his crime Hannah Brown's having deceived him as to the amount of her property.

THE CHEMISTRY OF THE STARS.

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In the article upon Spectrum Analysis (page 143), it was shown that the examination of the rays proceeding from any light-source, with an instrument called a spectroscope, enabled the trained observer to assert with certainty whether the light-source was solid or liquid on the one hand, or gaseous on the other; and if it were gaseous, the examination furnished him with the means of deciding, in the case of terrestrial elements, what was the nature of the substance producing that gas, and also, approximately, of determining the *temperature* and *pressure* to which the gas was subjected.

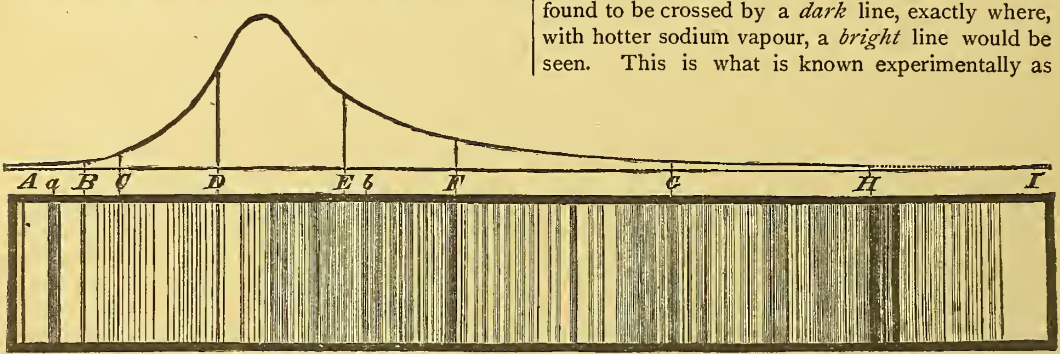


Fig. 1.—FRAUNHOFER'S MAP OF THE SPECTRUM IN 1814.

In approaching the study of the results obtained by the application of the spectroscope to the telescope, it is desirable that we should have a clear conception of what is known as Kirchhoff's "Law of Exchanges." We have seen already (see the "Rainbow and the Spectrum," p. 40), that the solar spectrum, instead of being a continuous band of colour, is crossed at intervals by dark lines. These were first mapped by Fraunhofer, who measured and drew 576 of them in 1814, and they are usually called after him. They are clearly seen in the annexed woodcut of Fraunhofer's original map (Fig. 1).

Fig. 2.—F, LINE DISPLACED IN THE SPECTRUM OF A SUN-SPOT.

A more minute examination of the solar spectrum, by Bunsen and Kirchhoff, revealed the existence of many hundreds of such lines, and it was presently noticed by these observers that the *bright* lines in the spectra of some terrestrial elements coincided exactly in their position in the spectrum with groups of *dark* lines in the solar spectrum. It was next shown experimentally by Kirchhoff that a gas, or vapour, through which rays from a light-source of higher temperature than itself are passing, is opaque to the particular rays in that light which the gas itself would give out when heated; or, in other words, that a gas *absorbs* those precise rays which it is capable, under other conditions, of itself *emitting*. For example, the bright yellow line in the spectrum of sodium (page 145, No. 3) was found to coincide exactly with Fraunhofer's dark line D (Fig. 1). Now, if the rays from the electric light are passed through the vapour of sodium, the spectrum of the voltaic arc will be found to be crossed by a *dark* line, exactly where, with hotter sodium vapour, a *bright* line would be seen. This is what is known experimentally as the "reversal" of the spectrum of sodium. The same process and line of argument may be repeated in the case of other metals, the lines in whose spectra (that of iron, for example) are numbered by hundreds. Hence the conclusion is irresistible, that in the sun's atmosphere there are many terrestrial elements, such as sodium, iron, calcium, magnesium, nickel, cobalt, chromium, manganese, titanium, and hydrogen in a state of vapour. The dark lines in the solar spectrum, then, tell us of certain vapours through which the sun's light has passed in its passage to the earth; some of them, beyond doubt, being due to metals volatilised in his atmosphere, while others are caused by various substances, notably aqueous vapour, occurring in the earth's atmosphere. Careful observations upon these latter lines, or bands, in an instrument specially constructed for that purpose (called the Rain-band spectroscope), afford meteorologists the means of foretelling rain several hours before its occurrence.

Another remarkable set of absorption-spectra are afforded by the sun-spots. The cavernous nature of these appearances was first noticed by Wilson, of Glasgow, early in the present century; and the periodic time of their return (eleven and one-third years) was formulated by Schwabe. Their size is enormous; into the smallest of them several of our earths might be dropped, while across the largest yet measured (1858) eighteen earths could readily be set in line. Combined observations of the telescope and spectroscope have incontrovertibly established that these sun-spots are really cyclones in the sun's atmosphere—down-rushes of colder vapour towards his centre, while the more intensely-heated vapour is brought to the surface at some other spot. Hence, the appearance of these spots is an indication of very great solar activity, and of increased rather than diminished supplies light is known by its position in the spectrum, it follows, when any line, or portion of a line, in a spectrum, is *displaced* from its normal position (as in Fig. 2), that this displacement, if towards the red end, indicates that the light-source is moving *from* the observer (or the observer from it), and if towards the violet end, that the observer and light-source are approaching each other.

The argument here used in the case of sun-spots applies equally to the spectra of the fixed stars, whose motions in the line of sight can thus be determined.

Let us now see what explanation is afforded by

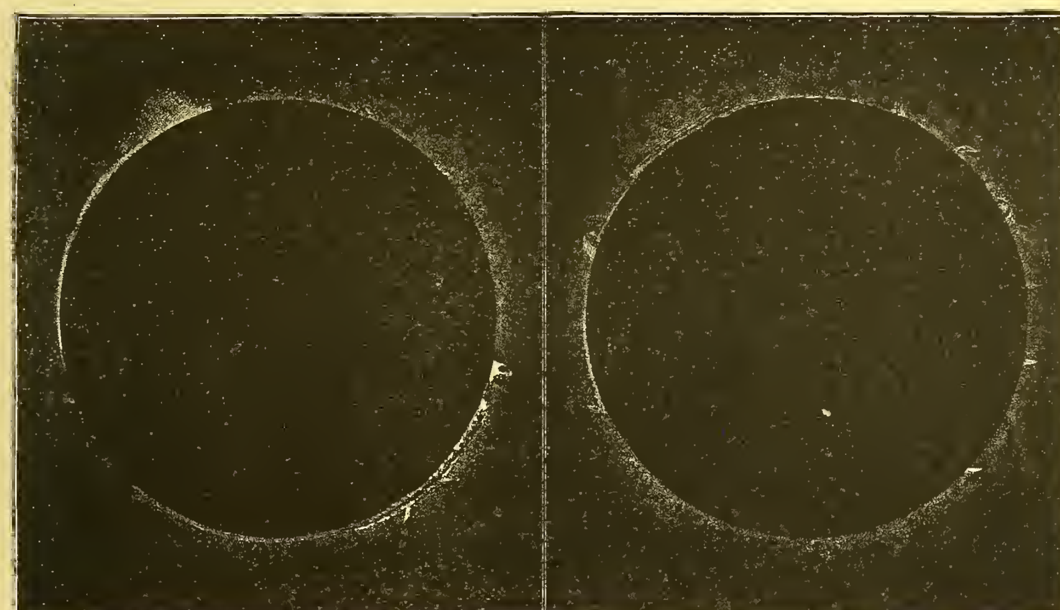


Fig. 3.—HYDROGEN FLAMES, SEEN DURING TOTAL ECLIPSE.

of energy being radiated from him. The fact that they are *down* rushes—*i.e.*, that the vapour is moving away from us—is shown by the *displacement* of certain lines in the spot spectrum, as seen in Fig. 2. For, recurring again to the analogy between light and sound, let us consider our own observation that the "pitch" of a locomotive whistle *rises* as the engine comes near to us, and falls as it recedes from us. The reason is that, as the whistle approaches, the number of impulses per second that fall upon the ear must be greater than when it is stationary or recedes, and *vice versâ*, while the pitch of a note depends on the number of such impulses per second. Now, since the number of waves per second entering the eye defines the colour or wave-length of light, and as the wave-length corresponding to each kind of

the spectroscope of the remarkable red flames (Fig. 3) which have for many years been noticed on the occasion of every eclipse of the sun. Telescopic and photographic observations had shown with tolerable certainty that they were solar and not lunar appendages, and the spectroscope at once revealed the fact that they were enormous masses of incandescent, or glowing, hydrogen gas, since their spectra presented the bright lines characteristic of that element. By a very simple modification of the combined telescope and spectroscope, it is now possible to observe these prominences at any time, even when the sun is visible, and a careful study of them has brought out some very marvellous results; especially in regard to their enormously rapid change of state, and the extent of the motion of the gas, which amounts in some instances to 120 miles per second. An inspection of the two following illustrations (Figs. 4 and 5) will give some faint idea of the magnitude of these changes.

It may be asked whether there are any other bright lines than those of hydrogen visible either in these prominences, or in the lower portions of the sun's chromosphere (as that portion of his atmosphere is called where all phenomena are most vivid), from which these prominences arise. The reply is, that the bright lines of several of the more easily vaporised terrestrial metallic elements are not unfrequently seen there, although, being so much less volatile than hydrogen, their prominences do not attain nearly the same height. The bright lines of the spectra of sodium, magnesium, and less frequently of iron, and a few other metals, occur in this way.

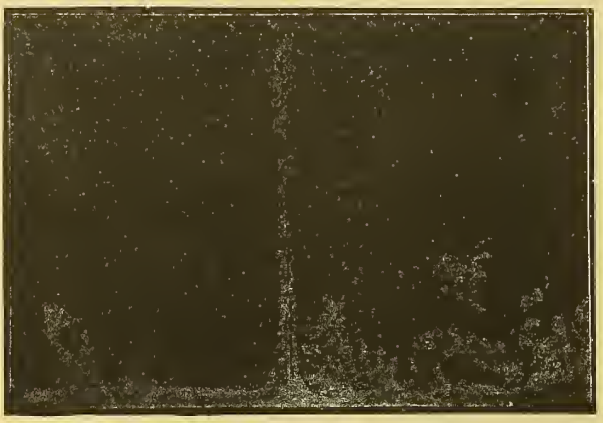


Fig 4.—A FLAME OBSERVED BY ZÖLLNER, IN 1869, AT 10.22.

Fig. 5.—THE SAME FLAME AT 11.20.

Of the spectrum of the Corona, that very marvellous solar appendage (Fig. 6) which is visible only during an eclipse, and which was seen to extend through 12,000,000 of miles at the 1882 eclipse by the observers stationed in the exceedingly clear atmosphere at the top of Pike's Peak in the Rocky Mountains, it is difficult to speak with certainty, since the observations are so few. The most probable supposition is that the Corona is really an extension of the higher regions of the sun's atmosphere; and, according to the latest hypothesis, that its spectrum is due to an integration of all the radiations and absorptions of these excessively complex layers. Recently Dr. Huggins has discovered a method of photographing the Corona whenever the sun is visible in a clear sky (*i.e.*, at other than eclipse times), and this new method of approaching its study cannot fail to largely increase our knowledge of it.

Let us turn now to the spectra of some of the other heavenly bodies. The spectrum of the moon as well as of every planet in the solar system, shining as it does, not by its own light, but by light reflected from the sun, naturally presents but few points of interest, and spectrum observations upon the moon and planets are chiefly devoted to the detection of the presence of watery vapour therein, as shown by its absorption-spectrum. When a star is occulted by the moon, the star-spectrum is carefully watched for evidences of aqueous vapour in the moon's atmosphere, which, if present, would cause the characteristic absorption-lines to appear in the star-spectrum just before occultation. Such observations are almost invariably negative in their results.

In the case, however, of the fixed stars, which shine by their own light, the results are very different; and it may be stated broadly that in *general* constitution and character the fixed stars resemble our own sun, their spectra presenting a continuous band of colours crossed by dark absorption-lines. At the same time, while many of the lines are identical with those shown by our own sun, many others are not so. Just as in the sun, also, many of these absorption-lines do not coincide with those of any known terrestrial element, so is it with the star-spectra. Further, as far as is at present known, the same elements are not present in all stars. We have long known that "one star differeth from another star in glory;" we now know that they differ more or less in general chemical constitution, and in the proportion of the elements that compose them. For instance, it is remarkable that Betelgeux and another star differ from our sun and all other stars so far observed, in showing no signs of hydrogen ; and the puzzling nature of this fact will be understood from what has been said before concerning the prominent part which the combustion of this gas evidently plays in the economy of the sun and other stars. Aldebaran, again, is remarkable in another way. There is a metal, tellurium, very rare on this earth, from which it is named ; and of which no trace at all can be found in our own sun, belonging to our own system; yet the lines of tellurium are very prominent in Aldebaran.

In May, 1866, a very remarkable phenomenon was noticed in the variable star *τ* Coronæ, which seems in part to explain some of those long-observed phenomena of variability in the amount of light given out by some stars. The phenomenon really was a gigantic outburst of glowing hydrogen gas, and the bright hydrogen lines appeared superposed upon the ordinary spectrum of the star (Fig. 7). To this phenomenon the title of a "world on fire" may indeed with truth be applied.

Fig. 6.—SOLAR CORONA, AS SEEN DURING THE ECLIPSE OF 1860.

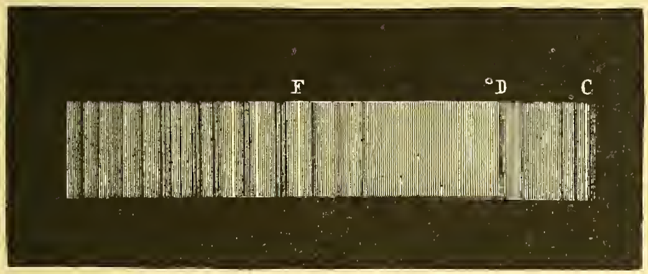


Fig. 7.—SPECTRUM OF *τ* CORONÆ.

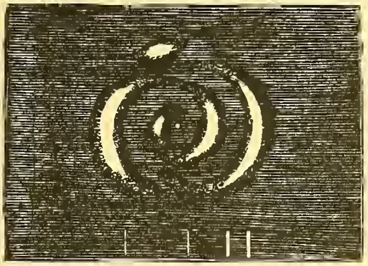


Fig. 8.—SPIRAL NEBULA AND ITS SPECTRUM.

The study of star-spectra has been greatly facilitated by photography, but the difficulties in the way of obtaining successful photographs are very great, owing to the small quantity of the light. To obtain a spectrum at all, a special contrivance has to be resorted to. Since the telescopic image of a star is a point, the elongation of this by the prism gives merely a line, and hence, in order to obtain the necessary width of band for a spectrum, the image of the star is elongated by the use of a cylindrical lens ; and this elongated image is thrown upon the slit of the spectroscope. Since, even with sensitive dry plates, an exposure of frequently an hour or more is necessary, the greatest perfection of apparatus is needed to keep this line of light always upon the slit, in consequence of the earth's rotation, and hence some of the difficulties that have been successfully overcome by Dr. Huggins may be realised. It is an overpowering thought that, notwithstanding the enormous velocity of light (about 180,000 miles per second) the waves that produce these changes on the photographic plate were set in motion at the star's surface decades of years ago !

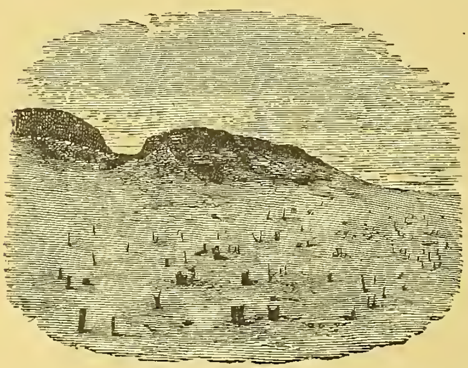
The results of the spectroscopic examination of nebulæ are very interesting. The telescope has been able to resolve many of them into star-clusters ; but of those which have hitherto eluded this analysis, the prismatic examination of their light has shown that they are, in the main, composed of glowing hydrogen, their spectra consisting of a few bright lines, as seen in Fig. 8. The resolvable nebulæ give a more or less continuous spectrum, indicating glowing liquid or solid substances, or matter in a more advanced stage of condensation from the universally-diffused fire-mist, which, on the nebular hypothesis, was the antecedent of all the heavenly bodies.

The spectra of meteorites also give evidence of the presence therein of several terrestrial elements, and notably of hydrogen, which has been actually discovered by laboratory analysis to exist in them in the free state amongst the pores of the metallic substance of the meteorite. This affords a striking and tangible confirmation of the results of spectroscopic research.

Of late years cometary spectra have absorbed much attention, with the chief result of demonstrating the presence in comets of certain gaseous compounds of carbon and hydrogen. On one of the most recent of these wandering visitors, however, the exceedingly interesting observation was made, that as the comet approached the sun, certain other substances, such as sodium, presumably existing in its nucleus, were volatilised by the sun's heat, and their bright lines appeared in the comet's spectrum; only to disappear again as the comet receded from the sun.

WATER FROM SUBMARINE WELLS.

THE water which supplies our wells frequently comes from a considerable distance. That which rises in the artesian wells of London is gathered by

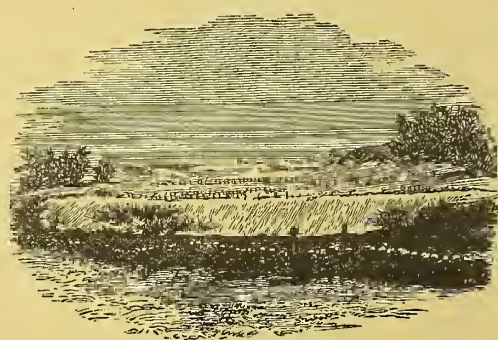


ROCKS AND CORAL SAND.

the Thanet sands at their outcrop to the north and south at a distance of from thirteen to twenty miles. Ears of grain and other vegetable products observed in an artesian well at Tours were traced by careful investigation to the department of Ardeche, above 250 miles away. In the Sahara wells of this description have been successfully sunk where there is no rainfall for hundreds of miles. In the great desert of Southern Africa there are extensive tracts without a drop of surface-water. The population feed their cattle on water-melons, and draw the water they require for domestic use by sucking it through reeds from a soft cavernous limestone which underlies the soil, and allows the flow of copious subterranean streams from the north. Our army in Abyssinia supplied themselves, it will be remembered, by a similar, but less primitive, apparatus.

But by far the most remarkable source of the supply of potable water is that drawn upon by the comparatively numerous population of Bahrein, on the shores of the Persian Gulf. There is no rain, and there are no land springs in this locality, which is probably the hottest and driest region on the earth, exceeding in that respect even the thirsty plains similarly situated between the Andes and the Pacific; but springs having their origin in the hills of Oman, five or six hundred miles distant, here rise in the salt waters of the gulf. From these the people of Bahrein draw their water-supply after the following remarkable fashion, as narrated in a recent work.

A diver, winding a great goatskin bag round his left arm, one hand grasping its mouth, takes in the other a heavy stone, securely held by a strong line which is tied to his boat. Plunging with this, he reaches the bottom quickly. Instantly opening the bag over the strong jet of fresh water, he springs up in the ascending current, at the same time closing the bag. The stone is then hauled up, and the diver, after taking breath for a few minutes, repeats the process.



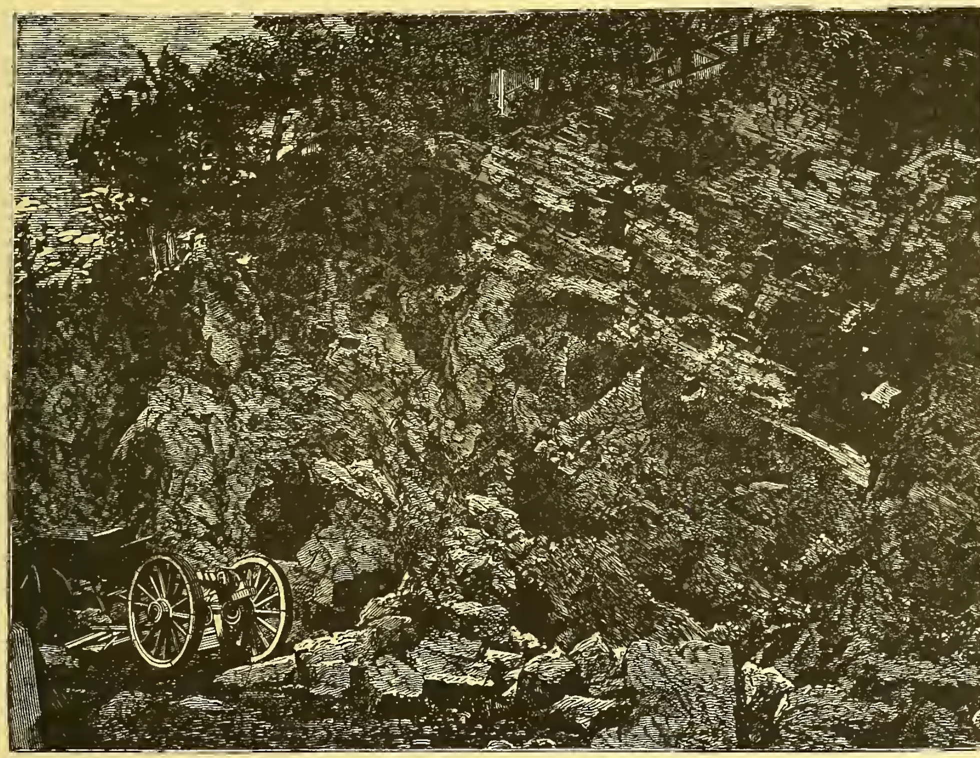
GLACIS OF MASS OF MOVING SAND.

A "SAND GLACIER" IN BERMUDA.

ON the south shore of the main island in Bermuda, at a spot called "Elbow Bay," there is a very remarkable instance of a "sand glacier." It has long been one of the "lions" of Bermuda, but seems to have been brought forth from its hiding-place most prominently by the late Sir Wyville Thomson, in his "Letters from the *Challenger*." At the point mentioned the shore is exposed to the full force of all winds which blow from the southward, and the surges beating continually on the friable coral rocks and reefs which fringe the coast, have reduced their upper surfaces to a fine powder. This sand, driven by the wind, has entirely filled up a considerable valley, and is now steadily advancing onwards and upwards in a mass about twenty-five feet thick. If the wind is at all fresh, a light haze or dimness is observed over the entire surface of the land, and on holding a sheet of paper perpendicular to the surface and transverse to the direction of the wind, the fine white sand is seen to fall rapidly from its windward side and to bank up before it. The glacis, or front of the advancing embankment, is very regular. The deluge of sand has already partially overwhelmed a garden which unfortunately lay in its course.

One owner succeeded, by planting cedars and oleanders, in diverting its direction just as it was on the point of engulfing his home and land ; but a neighbour appears not to have been so fortunate, because to the visitor's eye nothing remains to mark where his cottage stood except a solitary chimney, which projects above the ground, and over this a lovely oleander weeps. During its progress inwards from the beach the "glacier" has completely overwhelmed a wood of cedars, the bare stumps alone testifying to the former existence of the trees.

It would appear indeed that the only way of stopping this destructive invader is to cover it with vegetation. In Bermuda the oleander already mentioned grows in great profusion, and it is said that if watched and watered for some time it will take root and flourish even in pure sand. If this precaution is adopted, as we believe is now the case, the motion of the sand will be completely checked at no distant date. Meanwhile the wearing effect of the loose sand dashed against the rocks by the force of the wind, even in the interior, is very surprising.



STRATIFICATION OF SAND-BLOWN LIMESTONE.

WILD HUMAN BEINGS.

In the year 1749, on the 15th of March, a couple of Hungarian fishermen, named Franz Magy and Michael Molnar, captured, in a wild, desolate morass called Hansag, a strange creature, whom they at first took for some wild animal, but found it human. It had the form of a boy of about ten years of age, with limbs of unusual length and strength, and fingers and toes of about double the ordinary length, peculiarly strong and pliable. The skin was hard and scaly, with peculiar knots or wens in parts of it, and the head was perfectly round. The eyes were small, bright, and sunk, the nose hooked, and the mouth very large. They contrived with some difficulty to lodge their prisoner in the castle of Kapuvar, where attempts were made to civilise and educate him, but with very little effect, as he seemed unable to understand their language, and could not articulate a single syllable. It was twelve months before they could induce him to wear clothes, but he became gradually reconciled to them, as he at last did to cooked food instead of that of which, at first, he alone would partake—namely, grass, hay, and straw. His chief delight was plunging in the castle moat, in which he dived and swam as if it were his native element, and from which it was always difficult to induce him to emerge. When it was supposed that he was perfectly tame and reconciled to his new life, he was given his liberty; and the first use he made of it was to escape. He was seen afterwards by some fishermen in the morass where he was first discovered, and to which it was supposed he had returned by swimming down the river Raab, which ran close by Kapuvar. On that occasion he evaded capture by running into the reeds and rushes to a small lake called Konigsee, into which he dived, and remained under water so long that his pursuers never saw him again. Although watched for, he was not again seen until after the lapse of several years, when the party who saw him once more failed in his capture. This attempt was duly recorded (Amts-Kanzley Kapuvar, Schloss Kapuvar, August 21st, 1753); and from that time no reliable account of his reappearance seems to have been given, although all kinds of strange rumours were current concerning him amongst the peasantry.

In the year 1781 a wild man was captured in a forest near Kronstadt in Transylvania. He was exhibited for several years in different parts of Germany and Hungary: but although induced to conform to the habits of civilisation, he never seemed to possess the faculties of speech and reason. He was exhibited for many years, and finally died at an advanced age, in a small village, where his occupation was that of drawing water for the inhabitants, upon whose charity he subsisted.

In 1731 the village of Songi was startled from its propriety by a strange creature with the form of a child of nine or ten years and the aspect of a wild animal. Her hands and face were black and strangely stained; she was clothed in skins, with a few old rags, and carried a thick iron-spiked stick. Those who saw her, overcome by superstitious fear, regarded her as a "devil"; and one man let loose a bull-dog at the child, which she killed with a single blow of her stick, and then jumped on the carcase as if with delight. She tried in vain to find a way into one of the houses, and at last ran off into a wood, where those who cautiously followed and watched her said that she climbed a tree, in which she appeared to go to sleep.

The Viscount d'Epinoy, hearing this, went with a number of the villagers into the wood in search of the wild girl. They found her in the tree, and it being supposed that thirst had brought her into the village, they placed a pitcher of water at its foot, retired a little distance, and concealed themselves. After a time she came slowly down, watchful and cautious, and pausing every now and then to listen and glance keenly around; at last she eagerly grasped the pitcher, and took a hearty draught, being evidently extremely thirsty. A motion of the onlookers startling her, she darted, with the nimbleness and swiftness of a squirrel, up into the tree. To again entice her down, a woman and child were directed to offer her food. Presently she came timidly down, took the food, and was caught. She struggled to escape with frantic desperation, but vainly; and being carried to the house of the Viscount, was taken into the kitchen, where some fowls were being prepared for the fire. One of these she immediately seized, and, tearing it into pieces, ate it. An unskinned rabbit being given to her, she tore off the skin, pulled it to pieces, and devoured it also with extraordinary speed and voracity. It was found that she was able to speak only a word or two in some foreign tongue; that she would allow no one to touch her without uttering a strange, harsh shriek of fear and anger; that her skin was really white and delicate, but had been stained or painted black over the hands and face. She had unusually large thumbs, supposed to be due to her habit of climbing.

M. d'Epinoy placed her under the care of a shepherd, who found her a very troublesome charge. She dug holes in the room that she was confined in, and when she could escape made recapture very difficult by the speed with which she ran, the height she could leap, and the facility and swiftness with which she climbed trees, or got to the house roof. At first she would feed upon raw flesh, fish, roots, fruits, leaves, and even branches, swallowing meat whole without chewing; and after a time, when the desire to escape had died away, she was permitted to cater for herself in the fields and ponds. She swam and dived like a duck, and was extremely dexterous in catching fish, which she brought ashore in her teeth to gut and eat. Frogs were dainties for which she had a special liking, and on one occasion she made her appearance in the dining-room of the Viscount with her apron full of frogs, which she gleefully and rapidly distributed before the guests, placing one or more upon the plate of each of the company, ladies and gentlemen alike, whom she had previously amused by exhibiting her powers in chasing and catching rabbits. The confusion, alarm, anger, and laughter which ensued when the frogs began their leapings may be easily imagined. Her fearlessness was remarkable, and she would fight a wolf or wild cat with her stick shod with iron and spiked, which, she said, came from "the hot country."

She was gradually civilised, and, learning to talk, told her story. She and another girl somewhat older, she said, were once together. They had escaped to the shore from a ship by swimming. They had wandered together away a great distance, and crossed a river—supposed to have been the Marne, three leagues from Songi—travelling by day, sleeping by night in trees, and living on wild fruits and animals. Once they had a desperate quarrel, fought savagely, and parted. That was all she could tell.

Search was made for the other girl, but in vain; although it was said some time before the body of a girl, with the hands and face painted black, had been found not many leagues from the spot where the first was taken, but no one knew whether the body had been buried or not. Putting together all the vague disconnected statements made by "The Wild Girl of Champagne," as she was called, it was conjectured that Le Blanc, as the Viscount named her, had been kidnapped and carried to the West Indies, where her face and hands were blackened for the purpose of selling her and her companion as black children: that the trick was discovered, and the children again carried away in the slave-dealer's vessel, from which they escaped by swimming when off the French coast.

Le Blanc spent her after life partly in the hospital at Chalons, partly in a convent, where many curious people of high rank saw her and were kind to her, the Duke of Orleans amongst others. In 1765 she was in Paris, where it is believed she died.

In November, 1725, a wild boy, apparently about thirteen years of age, without clothing, who walked on both hands and feet, climbed like a squirrel, and fed on moss and grass, was captured in a wood near Hameln. The superintendent of the House of Correction at Tell brought the strange creature to Hanover, and presented him to King George I., who was then there, while he was at dinner. The king made him taste every dish, and gave instructions for him to be tamed and civilised. Soon after he escaped, and being tracked to a wood, sought refuge in a lofty tree, from which, as the surest and quickest mode of re-capture, he was dislodged by cutting down the tree. In the beginning of 1726 he was brought over to this country, where he was first called by the name he ever after bore—Peter, the Wild Boy.

Peter had neither words nor ideas, wore clothes with great reluctance, and could never be induced to sleep in a bed, preferring to crouch down in a corner of the room, as if sitting on the branch of a tree with his back against its trunk. He was placed under the care of Dr. Arbuthnot, whose efforts to teach speech or promote thought were equally vain. He was afterwards confided to the care of a Berkhamstead farmer, who received from the king a yearly pension for his support.

In 1782, when the wild *boy* had become an old man, Lord Monboddo visited him, and wrote: "He retains so much of his natural instinct that he has a forefeeling of bad weather, growling and howling and showing great disorder before it comes on. If he hears any music he will clap his hands and throw his head about in a wild, frantic manner. He has a very quick sense of music, and will often repeat a tune after once hearing. When he has heard a tune which is difficult, he continues humming it a long time, and is not easy till he is master of it."

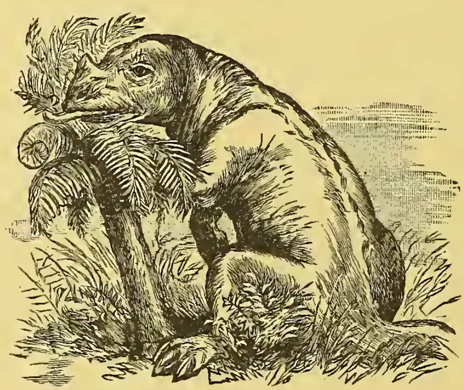
In the spring of the year he was always merry and happy, loved to bask in the sun, and stare at the moon and stars. In cold wintry weather he grew peevish and irritable, but was generally not easily provoked, although his anger, when it was aroused, was very fierce, and while it continued he would gnaw his hand. He was strongly attached to his master, and pleased to be useful, but required watching. Being once instructed to fill a dung-cart, he did so with great speed and vigour; but in his desire to please, went beyond that, for while the men's backs were turned, he just as rapidly and energetically emptied it. Peter died in 1785 at a farm in Hertfordshire.

In 1798 a wild child was captured in the woods of Caine. He had been seen several times before scratching up roots and eating acorns, and was caught by some sportsmen while in the act of climbing a tree to escape them. He was about eleven years of age, and the scar of a large wound in the throat indicated that an attempt had been made to kill him. There were as many as twenty-three other scars on his body, some of which were supposed to be those left by the teeth of wild animals, and others those caused by thorns and deep scratches. It was believed that at least seven years of the boy's life must have been passed in absolute solitude. He lived for some time on raw acorns, potatoes, and chestnuts, eating husks and all; made frequent efforts to escape, was at first unwilling to sleep in a bed, appeared to be deaf, uttered only guttural, unintelligible noises, and had lost the power of smelling. After he had escaped and been re-captured several times he was taken to M. Itard, of Paris, who pronounced his senses not dead but dormant. It is said that during captivity his paroxysms of rage increased in violence and frequency, rendering him very troublesome but not dangerous, inasmuch as they were directed rather against inanimate than animate objects, which he seemed to have a vicious pleasure in destroying. These paroxysms generally ended in convulsions resembling those of epilepsy.

EXTINCT BRITISH REPTILES.

It appears a strange and wondrous thing when one is told for the first time that in this country there was once a kind of crocodile somewhat similar in size and nature to the gavial of the Ganges; that on the land huge beasts, bigger than anything now living, either at home or abroad, roamed in forests of tree-like ferns, palms, and coniferous trees, until they died out; while strange creatures flew through the air or shuffled along the ground which were neither birds nor bats, but more like the horrid and fanciful harpies Flaxman has sketched in one of his illustrations of Homer's Odyssey. That there were such creatures in the land millions of years ago, in what geologists have termed mesozoic times, is now a demonstrated fact. It was the age of gigantic and remarkable reptiles.

One of the earliest crocodile skeletons found was unearthed from the alum shale (lias) of the Yorkshire coast about half a mile from Whitby, and was subsequently described in the "Philosophical Transactions" for 1758. Incomplete as it was, it measured fifteen feet two inches long, and when entire was probably about eighteen feet in length. Two more have been found since. The teleosaurus —the name which has been given to this ancient crocodile—must have been a rapacious brute, formidable even to some of the terrible reptiles that then lived, as it had long jaws for seizing its prey, filled with dangerous-looking teeth, and its whole body was enclosed in natural armour-plates. These cuirassed creatures dwelt on the banks of rivers, but probably kept more to the sea than the modern crocodile, and must have been well acquainted with the ichthyosaurus and plesiosaurus, which are elsewhere described in this work. What are supposed to have been the eggs of a teleosaurus were found near Cirencester some years ago, being round oval bodies, an inch and three-quarters long and one inch wide.



IGUANODON.

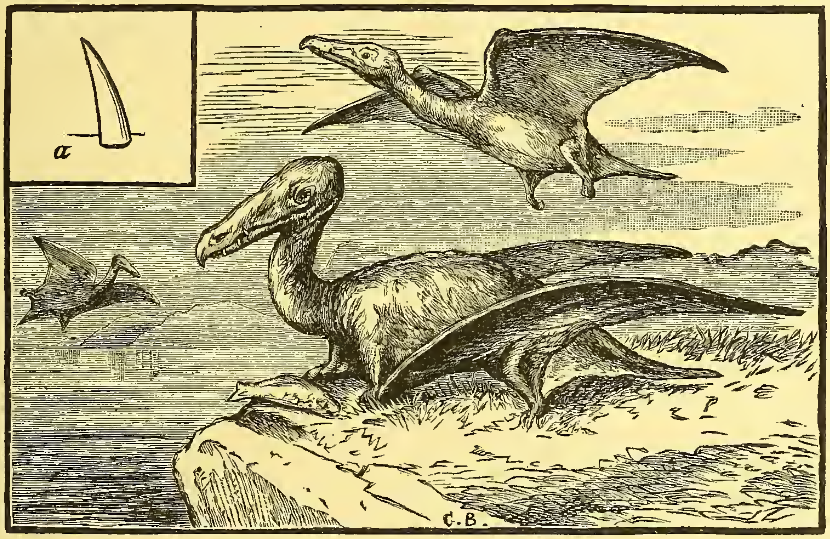
There were huge herbivorous reptiles living on land contemporaneous with the teleosaurus. They were of such a size that their living representatives—lizards like the iguana of South America—are small indeed in comparison. The iguanodon was one of them. It was twenty feet long, on Professor Owen's very moderate estimate; but there have not been wanting geologists to declare that its length must have been as much as seventy-five feet. Its remains were first found in Tilgate Forest by Dr. Mantell. This geologist remarks that "the body of the iguanodon was equal in magnitude to that of the elephant, and as massive in its proportions; for, being a vegetable feeder, a large development of the abdominal region may be inferred. Its limbs must have been of a proportionate size to sustain so enormous a bulk; one of the thigh-bones (in the British Museum) if covered with muscles and integuments of suitable proportions, would form a limb seven feet in circumference. The hinder extremities, in all probability, presented the unwieldy contour of those of the hippopotamus or rhinoceros, and were supported by very strong, short feet, the toes of which were armed with claws, like those of certain turtles. The fore legs appear to have been less bulky, and were furnished with hooked claws resembling those of the iguana." It was a gigantic but inoffensive reptile, living on the vegetation of the country about the Wealden. Its mode of living is attested by the nature of its teeth, which resemble those of the iguana; hence its name—*iguanodon.* The hylæosaurus, or wood lizard, which lived in the same age and roamed in the same forests, was probably as harmless as the iguanodon. It was a herbivorous reptile, from twenty to thirty feet in length. Its probable form, with short thick limbs and tail, and back bristling with thick spines, is well shown in the restoration of its form, by Mr. Waterhouse Hawkins, which is to be seen at the Crystal Palace, Sydenham, London. The passenger from London to Brighton seldom gives a thought to these creatures of the past; he is, however, passing over the lands where their fossil remains have lain preserved for ages. Quarries along the roads leading from London to the south-eastern coast are numerous, and one may safely say that there are few which have not yielded their share of these remains, especially in the area of Tilgate Forest.

But these *fearfully great lizards* (Dinosaurians) were not all vegetable-eaters. There was one—well called megalosaurus, on account of the size of its fossil bones—whose curved serrated teeth (combinations of sabre, saw, and knife) were used for remorselessly slaying, tearing, and cutting up its prey. Its head was five feet long, while the whole body, from head to tail, was about thirty feet in length. One can imagine that a piece of hylæosaurus or iguanodon would be no unwelcome meal for such a monster, although it may have regarded as daintier morsels the smaller denizens of the water. Phillips remarks on this point: "The remains (of megalosaurus) are found scattered in a lagoon, or shallow estuary, and it is conceivable that the fishes which abounded in that water were the favourite food of the carnivorous reptile. One seems to behold him wading by his long legs, or swimming by help of the tail, a gigantic triton among not inconsiderable cephalopods, whose tough muscles he shared with the frequent voracious sharks."

In this age of ours it is the rule for a bird to be a bird and a beast a beast, with well-marked distinctness; in the wondrous times of which we write an animal might unite in itself the peculiarities of both, even if it had no wings. Thus, the megalosaurus had a sort of kinship to the ostrich in the structure of its pelvic girdle; it was allied to the crocodile in having a somewhat similar backbone, while in the form of its teeth it claimed kindred with the monitors. In the essential arrangement of its parts, however, and other characteristics, it was a true reptile. The remains of this great fish-eating lizard have been found at Lyme Regis, Weymouth, Malton (Yorkshire), and other places in England. It has no rival among carnivorous reptiles.

In 1870, portions of the ribs, shoulder-blades, and thigh-bones, &c., of a gigantic animal were found in the excavations of Enslow Rocks, Kirtlington Station, north of Oxford. A critical examination of these bones has led to the inference that the full-sized animal was fifty feet long. It has been named the ceteosaurus, or whale-lizard, but one is able to form but a dim and uncertain picture of this extinct monster. It was one of the largest reptiles on land or in the sea, standing not less than ten feet in height, and being of a bulk in proportion. It rivalled the largest of living whales in size, and is supposed to have had webbed feet and a broad vertical tail. It is not known for certain whether it lived in the sea, in fresh waters, or on the land; for its bones have been found in places which would lead equally to each one of these conclusions.

And now we come to a more extraordinary form of life than any we have so far described—so extraordinary that one has a difficulty in drawing a mental image of it. Let us picture a crow stripped of all its feathers, and with a long, tapering tail; with sharp fangs projecting from its jaws; with four legs, and wings stretching from the two fore legs. Of some such form was the *rhamphorhynchus*, a flying reptile akin to the pterodactyle. It was a member of a race of predaceous tyrants which ruled the air, when birds such as we have now were of rare occurrence. It is thought by some to have been competent to dive; its structure showing it to hold the same relation to its contemporaries the ichthyosaurus and plesiosaurus that the pelican and the tern hold to the dolphin to-day. It is not surprising to find some divergence of opinion as to the form of so extraordinary an animal, and the picture we have drawn of it is what Professor Phillips imagines to have been its appearance.



RHAMPHORHYNCHUS. (*a*) TOOTH, NATURAL SIZE.

Such are the strange beings that geological research has made known to us, rivalling in fantastic forms the fiery dragons of romance. Since they lived there have been great changes in animal forms, and it may also have occurred to the reader that there have been other changes also; for surely if crocodiles, and tree-lizards, &c., lived here in past ages, there must have been a wondrous change in the climate. Geological facts show that the climate was then tropical, and that the distribution of land and water was different; so that we do not know whether our country was then an island or only part of a continent.

THE SLEEP OF PLANTS.

THE phenomenon popularly known as the sleep of plants, and first so named by Linnæus, had been observed long before his time. Theophrastus, an ancient Greek botanist, born about 350 B.C., describes the flower of a species of water-lily as closing and sinking under the water in the evening, and rising and expanding in the early morning. The common water-lily of our ponds closes its flowers in the afternoon, and lays them down upon the surface of the water till morning, when it expands and raises them, often, in a bright day, to several inches above it. Regularly recurring periods of seeming repose are common to many species of plants, generally during the night-time, although there are many exceptions, some going to rest early in the day; while the night-blowing cereus, the œnotheras, or evening primroses, some silenes, or catch-flies, and several others unfold their blossoms in the evening or night-time, their flowers closing or withering away at daybreak. The great majority of plants, however, that have been observed to "sleep" take their rest in the night. The flowers of numerous composite plants, such as the daisy, marigold, sunflower, &c., display this peculiarity conspicuously. The leaves of plants are affected in the same way as the flowers, as may be distinctly observed by examining a field of clover in the evening, and the action is very noticeable in the leaves of the *Robinia pseud-acacia*, the acacia of our shrubberies, and in its frequent companion, the laburnum. The leaflets of the acacia are extended nearly in a horizontal direction at sunrise, but as the day advances they gradually rise till they become almost vertical, falling again as the day declines. In a field of corn, the leaves may be seen to become flaccid, and the ears to droop, after nightfall. Curiously enough, also, but easily intelligible, when by an eclipse darkness is spread over the face of nature, the flowers and leaves of night-sleeping plants rapidly close up; and if, on the other hand, the light of a candle be introduced during night, plants then asleep will be prematurely roused, or they may be kept dormant by shutting out the dawn. The circumstance which led Linnæus to the investigation of this peculiarity of plants is worth relating. A correspondent had sent him the seeds of a new species of Lotus (bird's-foot trefoil). The red flowers which sprang from them, we are told, excited his admiration, and as his gardener was absent when they came into bloom, the great naturalist took him into the greenhouse immediately on his return to show him this new floral treasure. To his surprise and vexation, however, he found that the flowers had disappeared, although on the following day they reappeared in all their pristine beauty. He at first supposed that those he had previously observed had been eaten by insects; but not quite satisfied on that point, on the next evening he examined the plant carefully, leaf by leaf, until he discovered the blossoms quite hidden by the drooping foliage. It is possible that this folding of the leaves round the flowers answers the subsidiary purpose of sheltering them from the dew, which is of considerable importance in the economy of the plant.

The cause of the sleep of plants has been the occasion of much controversy among vegetable physiologists. Many motions of plants, such as the twisting of the stems of the hygrometer moss, are more or less mechanical. Neither, apparently, are those under consideration altogether owing to the action of light, although a flower taken from the dark will often expand beneath a lamp. Lindley indeed contends that it is obvious there must be some cause beyond light, seeing that many flowers will close in the afternoon while the light of the sun is still playing upon them, and the petals of others fold up under a bright illumination. He concludes that the cause may be reasonably supposed to be an excitable vital fluid; yet it is, on the whole, probable that these periodical movements depend mainly on the action of light.

There are numerous allusions to the sleep of plants in the poets. Shakespeare, for example, refers to

> "The marigold, which goes to bed with the sun,
> And with him rises weeping;"

while Withers, with a quaint pathos, details how, "duly every morning," the same flower displays

> "Her open breast when Phœbus spreads his rays,"

and how she

> "veils her flowers when he is gone,
> As if she scornèd to be looked upon
> By an inferior eye;"

and the Ettrick Shepherd sings of the "gloaming"—

> "When the blewart bears a pearl,
> And the daisy turns a pea,
> And the bonnie lucken-gowan
> Has faulded up her ee."

The "blewart" is the beautiful *Veronica chamædrys*, that ornament of the waysides in summer, the flower of which folds up in the evening into a circular glossy bluish-white ball, aptly compared to a pearl.

Linnæus, who has treated this subject at length in his "Amœnitates Academicæ," constructed a Horologium Floræ, or floral dial—a table of the hours at which forty-six plants open and shut their flowers in the latitude of Upsal. He divided flowers in this relation into three kinds—meteoric, which, being dependent upon the moisture and other conditions of the atmosphere, are not punctual in their periods of expansion and closing; tropical, which, opening in the morning and closing when the sun goes down, close earlier or later as the length of the day increases or declines; and equinoctial, which unfold regularly at a stated hour, and have generally also a determinate hour for commencing their periodical sleep. The following is a floral dial composed of plants, the greater number of which are either wild, or cultivated in England, and covering the period from three in the morning till nine at night:—Goats'-beard (*Tragopogon pratense*) opens at 3.5 a.m., shuts 9.10 p.m.; hawkweed picris (*Picris echioides*), 4.5 a.m., 12 noon; Alpine hawk's-beard (*Crepis alpina*), 4.5 a.m., 12 noon; wild succory or chicory (*Cichorium intybus*), 4.5 a.m., 8.9 p.m.; naked-stalked poppy (*Papaver nudicaule*), 5 a.m., 7 p.m.; blue-flowered sow-thistle (*Sonchus alpinus*), 5 a.m., 12 noon; field bindweed (*Convolvulus arvensis*), 5.6 a.m., 4.5 p.m.; common nipplewort (*Lapsana communis*), 5.6 a.m., 10 p.m.; spotted cat's-ear (*Hypochœris maculata*) 6.7 a.m., 4.5 p.m.; white water-lily (*Nymphœa alba*), 7 a.m., 5 p.m.; garden lettuce (*Lactuca sativa*), 7 a.m., 5 p.m.; mouse-ear hawkweed (*Hieracium pilosella*), 8 a.m., 2 p.m.; proliferous pink (*Dianthus prolifer*), 8 a.m., 1 p.m.; field marigold (*Calendula arvensis*), 9 a.m., 3 p.m.; purple sandwort (*Arenaria purpurea*), 9.10 a.m., 2.3 p.m.; chickweed (*Stellaria media*), 9.10 a.m., 9.10 p.m.

A FROZEN CREW.

IN 1774 a deserted ship of an uncouth form was discovered in the arctic region strangely encumbered with ice and snow, the yards and rigging dismantled, the sails strangely disposed, and the hull terribly battered and weatherworn. The discoverer was the captain of a Greenland whaling-vessel named Warrens, who, on boarding her, found in one of the cabins (into which he first peered through the porthole), the corpse of a man perfectly preserved by the frost, with the exception of a slight greenish mould which appeared about the eyes and on the forehead. The body was seated in a chair and leaning back, a pen was still in its right hand, and before it was the open log-book, in which the dead man had been writing when he ceased to breathe. The last complete sentence of the unfinished entry ran as follows:—

"November 11th, 1762. We have now been enclosed in the ice seventeen days. The fire went out yesterday, and our master has been trying ever since to kindle it again, but without success. His wife died this morning. There is no relief."

A strange feeling of awe crept over those who thus broke in upon the loneliness of the unburied dead, the unconscious explorer of this Polar sea, and the only real solver, perchance, of that mighty problem of the North Pole which has so long and fearfully baffled human skill and courage. Captain Warrens and his men retired in solemn silence, and on entering the principal cabin found on a bed the dead body of a woman, with all the freshness of seeming life in her attitude and expression; and seated on the floor, holding in his hands the flint and steel, which he seemed to be in the act of striking, the corpse of a young man. Neither provision nor fuel could be anywhere discovered.

In the periodical from which the above facts have been gleaned, the writer says, on returning to England Captain Warrens made various inquiries respecting the vessel, and by comparing these results with the log-book he had brought home, ascertained the name and history of the imprisoned ship, which for thirteen years had drifted in the calm and storm of the Polar sea, with its dead navigators within its tomb-like hull.

DUST EXPLOSIONS.

THE word "explosion" is so identified with gas, gunpowder, dynamite, and fireworks, that those who have not, during the past ten years, watched the published reports of certain disasters both at home and abroad, will peruse the heading of this paper with some surprise. To imagine that dust, which meets us at every turn in our homes, in our workshops, and in our streets, can represent a dangerous explosive, will seem to them to be a statement hardly worthy of serious attention. But we shall presently see that under certain favourable conditions, which can easily occur, dust is not only inflammable, but will actually inflame with explosive violence. Indeed, it is not too much to assert that it would be safer to carry a naked light through a gunpowder magazine, than through the passages of a building where dust is flying in the air unchecked.

Let us first remember in what ordinary combustion consists. It is the union of the oxygen in the air with a so-called combustible, one of the first conditions being that the oxygen must have free access to the substance burnt. A servant who knows how to build a fire in the grate is careful that the wood and lumps of coal are so arranged that many air-spaces remain between them. She will place the fuel bit by bit in its place with her hand, in preference to throwing it into the grate *en masse*. She knows well enough that were she to do that, the fire would, as she would say, be smothered. Let us take another illustration. If we take a piece of inch board, and try to inflame it by ordinary means, we shall have the greatest difficulty in doing so, for it has, roughly speaking, only two surfaces exposed to the action of the air. But if we take a carpenter's plane, and reduce the board to shavings, the oxygen can play on a hundred different surfaces, and the application of a flame will reduce the whole very quickly to ashes. The same thing holds good of many other things. A bound book, for instance, is a hard thing to burn, but if its leaves are separated it will be very quickly consumed. We shall now understand how dust, harmless when lying undisturbed, can, when raised in clouds in the atmosphere—so that each particle is wrapped, as it were, in an envelope of air—constitute a combustible mixture of no mean order. We will now proceed to give a brief account of several disasters which have been traced to explosions of different kinds of dust; and firstly, those which have occurred in flouring-mills.

In September, 1864, at the Stow flour-mills at Illinois, a miller found part of the machinery had become clogged in the process of grinding flour of a second-rate description called "middlings." He found the place of stoppage, thrust in his shovel, and sent the flour down in a mass. A cloud of dust followed, which took fire at the lamp which he carried. A sheet of flame rushed through the mill, and the building was destroyed.

Four years later a mill at St. Louis was destroyed in much the same manner.

In September, 1869, at Berchay's mill, Milwaukee, a candle was held near the spout through which the flour was passing. The dust ignited with a flash, which travelled through the mill so quickly, that every part of it seemed to be on fire instantaneously.

In July, 1872, the Tradeston mills, near Glasgow, suddenly exploded, and were destroyed in a general conflagration which followed. This disaster may be said to have been the first which aroused scientific attention to the matter. It was at the time considered so inexplicable, that the fire-offices interested set on foot an exhaustive inquiry. To the results of this inquiry we shall presently call attention.

In May, 1878, a still more disastrous explosion occurred at the Washburn mills, Minneapolis, one of the largest establishments of the kind in the world. By this explosion the building was destroyed as if it had been blown up by gunpowder; the city was shaken as if by an earthquake; windows were broken, and property destroyed in every direction, the total loss being estimated at nearly a quarter of a million sterling.

The Committee appointed to inquire into the circumstances which led to the destruction of the Tradeston mills examined many witnesses, and also inquired into accidents of a like nature before they gave in their report. In a paper bearing upon the subject, and recently read before the Society of Arts, we find a condensed account of this report, which gives so much practical information that we reproduce it. The Committee stated that—"1. The primary cause of the fire and explosion was the accidental stoppage of the feed of one pair of stones engaged in the grinding of sharps, which led to the stone becoming highly heated and striking fire. 2. That the fire thus generated inflamed the finely-divided dust which was diffused through the air in the exhaust-conduits, and then passed on to the exhaust-box. 3. That the sudden combustion of the dust diffused through the air would produce a very high temperature in the gaseous products of that combustion, and this would necessarily be accompanied by a great and sudden increase of pressure and bulk—constituting, in fact, an explosion. 4. That the first effects of this explosion would be to burst the exhaust-box, and allow of the diffusion of the dust and flame through the atmosphere of the whole mill. 5. That this communication of inflammable dust and flame throughout the atmosphere of the whole mill was the cause of the second explosion, by which the gable walls were blown out, the mill reduced to ruins, and the woodwork set on fire. 6. That the stores or granaries were set fire to partly by the flame and fire from the mill travelling along the gangways, and partly from the burning materials falling through the skylights. 7. That no explosive or other foreign material was used in the manufacture of the flour, and that we found the steam boilers uninjured. 8. That we have not been able to trace blame on the part of the proprietors of the mill, or of any one in their employment, as every precaution known at the time was used."

So much for flour-mills; now let us mention a few dust explosions of a more general character. In 1873, a factory was started at San Francisco for pulverising brimstone for the use of sheep-farmers. It was financially a great success; but one day, just after the machinery had been stopped, a terrible explosion occurred, followed by flames which quickly destroyed the building. The following year the place was rebuilt, and the manufacture once more resumed, when a similar disaster occurred, and the building was once more reduced to ruins. No lamp was allowed in any part of the works, and the men were forbidden to smoke. The cause of the explosion was never ascertained, but the proprietors had had lesson enough, and the industry was not renewed.

At Chicago in 1874, a man cleaning a portion of the machinery of a large fertiliser manufactory noticed that a quantity of dust had settled on his lantern and obscured the light. He opened the lantern in order to cleanse it, when he was astonished at an explosion which almost knocked him over, but did no further damage. The workman did not seem to profit by his experience, for he repeated his performance a week later, with the result that the building was burnt to the ground in the fire which followed.

At Messrs. Allsopp's brewery, Burton-on-Trent, an explosion occurred in 1877, which was traced to the dust arising from pulverised malt. Bearing upon this section of our subject, we may quote a correspondent of *Nature*, who writes : " There have been three explosions of malt-dust in our mill within four years, not due to any carelessness in allowing flame to approach impalpable dust, but ignited from a spark from a piece of flint passing through the steel rollers, or from excessive friction in some part of the wooden fittings."

In December, 1877, a wholesale candy factory at New York was completely destroyed by explosion. Two years later another candy factory in the same city suffered a like fate, and a third is recorded as having happened at Kansas city, when seven persons were killed, and much property destroyed.

In a great many of these terrible disasters, while people have learnt the cause of explosion, they have been quite unable to understand how in the absence of flame the dust has received its initial combustion. We venture to think that in the case of flour-mills this is not far to seek. Most grain has mixed with it particles of iron, which it has picked up during its various stages from the field where it grows to the mill where it is ground. More especially has this been the case since the introduction of agricultural machinery, and notably since automatic reapers and binders have been in use. These machines tie up the sheaves with wire, and it is easy to understand how small pieces of the metal become mixed with the grain. When such metal gets between the mill-stones fire is the natural result. The admixture of foreign metallic particles with grain is such a well-known evil, that magnetic screens are now commonly used to purify grain from them. These, together with large bowls full of the iron rubbish collected by them, have recently been on view at more than one electrical exhibition.

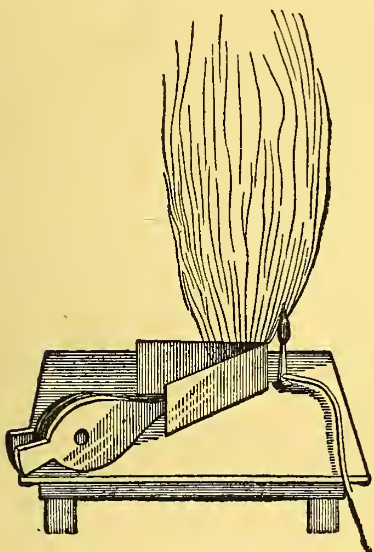


Fig. 1.

With regard to candy factories, we also find an agent which very possibly has been instrumental in first giving the starch-dust its flame. At many of these factories those Christmas crackers, which are so much relished by the juveniles, are manufactured. These contain a small portion of fulminate of silver, or mercury, which only requires a mere touch to explode it. We need hardly point out how the flash from such a source, harmless in itself, might be productive of harm in a dust-laden atmosphere.

From some unknown cause, possibly the greater dryness of the atmosphere there, these dust explosions seem to be far more common at the other side of the Atlantic than they are here. It will be noticed that a large proportion of the examples cited, which unfortunately do not represent nearly all the disasters of the kind known, have occurred in America. The millers at Minneapolis, Minnesota, were so impressed with the importance of the subject, that in May, 1878, they invited Mr. L. W. Peck to lecture to them upon dust explosions, with a view that they might understand them theoretically, and do their best to avoid such lamentable occurrences in future. The lecturer seems to have attacked his subject with great skill, and to have illustrated it with experiments which do great credit to his ingenuity. The first of these is shown in Fig. 1, and although of a simple character, is highly suggestive.

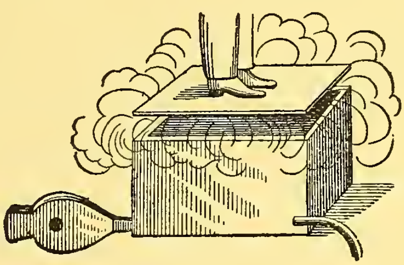


Fig. 2.

Two boards were so placed that they form an acute angle ; just inside the point where they meet, a little pile of dust, such as can be scraped from the corner of any carpenter's shop, was allowed to rest on the table. Just at the other side of the boards was placed, as shown, a Bunsen burner, fed by a gas-pipe from below the table. A vigorous puff from a pair of ordinary household bellows caused the dust to rise in a cloud, which immediately took fire, throwing out an intense heat, and raising a flaming column fifteen feet in height. The same experiment was repeated with starch and sugar, to show how it was possible for candy factories to prove bad investments to insurance companies. Next came buckwheat, which burnt well, flour, rye-flour, fine oatmeal, and many other organic substances, which inflamed with various degrees of rapidity.

The second experiment, shown in Fig. 2, was of a still more startling nature, for it gave evidence of the explosive violence which these apparently harmless dusts will exhibit when mixed with a certain quantity of air. A box of two cubic feet capacity has a loosely-fitting lid, upon which an

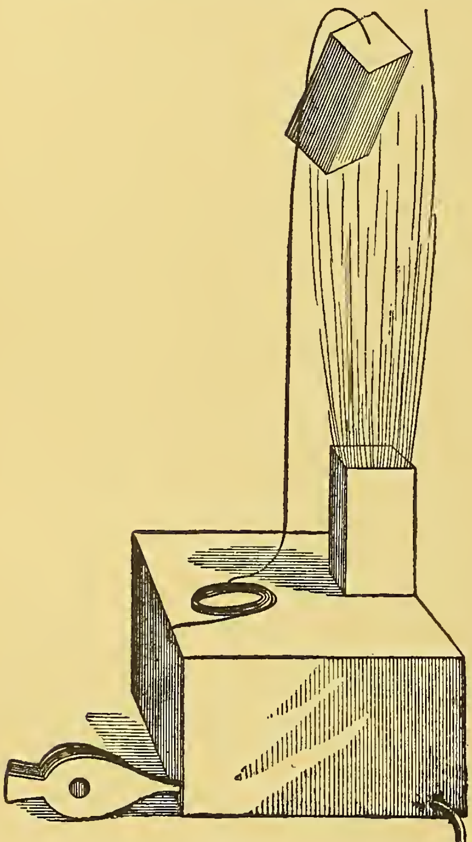


Fig. 3.

assistant took up his position. It had been previously charged with a small quantity of flour, by the side of which a Bunsen burner was placed. The puff from the afore-mentioned bellows was sufficient to fill the box with a cloud of dust, which exploded, and raised lid, man and all, a perceptible distance from the box. In the light of this experiment it is easy enough to understand how a building charged with inflammable dust can have its roof bodily lifted from its walls.

Fig. 3 is explanatory of the third experiment. A box of three cubic feet capacity had a kind of chimney attached to it, in which is fitted a cap of wood. This box had a kind of manhole in it, like that found attached to a steam boiler. Through this orifice the flour, or other dust, was placed in position, together with the Bunsen burner to inflame it. The nozzle of the bellows was inserted in a hole provided for the purpose, and when the air from it aroused the dust, the cap of wood was violently driven into the air, and would have injured the ceiling of the lecture-hall had it not been controlled by a cord, twelve feet long, which held it captive.

One more experiment, intended to show the disruptive action of a dust explosion, is illustrated in Fig. 4. Here we have a box made of 1½-inch wood on all sides but one. This last was only a quarter of an inch thick. The dust, bellows, and burner are arranged as before, and when the blast came it tore out the weak side of the box with explosive force, and a tongue of flame shot out of the opening to a great distance.

One curious effect of these explosions is, that they have led to an entirely new theory concerning those

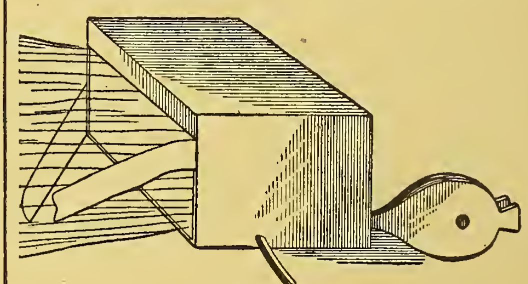


Fig. 4.

catastrophes in coal-mines, which have in some cases numbered their victims by hundreds. The scapegoat for these calamities is generally the poor miner, who is credited with such callousness that he will force open his safety-lamp to get a light for his tobacco-pipe. In other cases we are told that the mischief is wrought by blasting with gunpowder, the flame from which ignites the marsh-gas, or fire-damp as the men call it, present in the mine. The new theory is, that coal-dust in dry workings will, when mixed with a certain proportion of air and fire-damp, constitute a most explosive atmosphere. When once alight, it will fly along the workings and deal death and destruction in its path. The remedy is, in dry mines, where the passing of a few men will raise clouds of dust, to keep the ground well watered, as we water our roads above ground.

In conclusion, let us remark that many people, in their ignorance of the risk which they run, will allow dust to remain in their workshops, to cover neglected cobwebs on their walls, and to accumulate in every nook and corner. Should a fire occur, this dust, roused to sudden activity, will most surely carry the flames far from their original starting-point. A word to the wise is enough.

EXTRAORDINARY PREDICTIONS.

WHEN the late Countess of Moray was twelve years old, and a Miss Lockhart, of Carnwalt in Lanarkshire, a gipsy foretold that she would have two husbands, and that just before her death she would pass through a newly-felled wood, and be drawn in a carriage by a piebald horse to the house from which she would never come alive. The prophecy was very strangely realised. Miss Lockhart's first husband was the Earl of Aboyne : her second the Earl of Moray; shortly before her death she visited the Highlands of Scotland, and passed through the forest of Glenmore, then in process of removal, and on the following morning the coachman came to say that one of her four horses had died suddenly in the night, and that he had therefore borrowed another. It was a piebald one ! She went on to Culloden House, where she was taken ill, and after a short time expired.

It is recorded of the poet Dryden, by Charles Wilson, in his "Life of Congreve," that having, strange to say, belief in astrology, he was careful to ascertain to the second the time at which his son Charles was born. He then calculated the boy's nativity, and was alarmed to discover that evil influences prevailed in the heavens : Jupiter, Venus, and the sun being below the earth, and the lord of his ascendant afflicted with a baleful square of Mars and Saturn. He concluded that in his eighth year, and on the day of birth, his son's life would be seriously endangered if not lost; and that if he lived, the same danger would exist when he attained his twenty-third birthday, and again on his thirty-third or fourth. On the boy's eighth birthday, despite every precaution to keep the boy from every possible danger, he was nearly killed by the fall of a wall. On his twenty-third birthday he was seized with giddiness and fell from an old tower belonging to the Vatican at Rome ; and he was drowned at Windsor while swimming across the Thames in his thirty-third year.

MUSCULAR POWER.

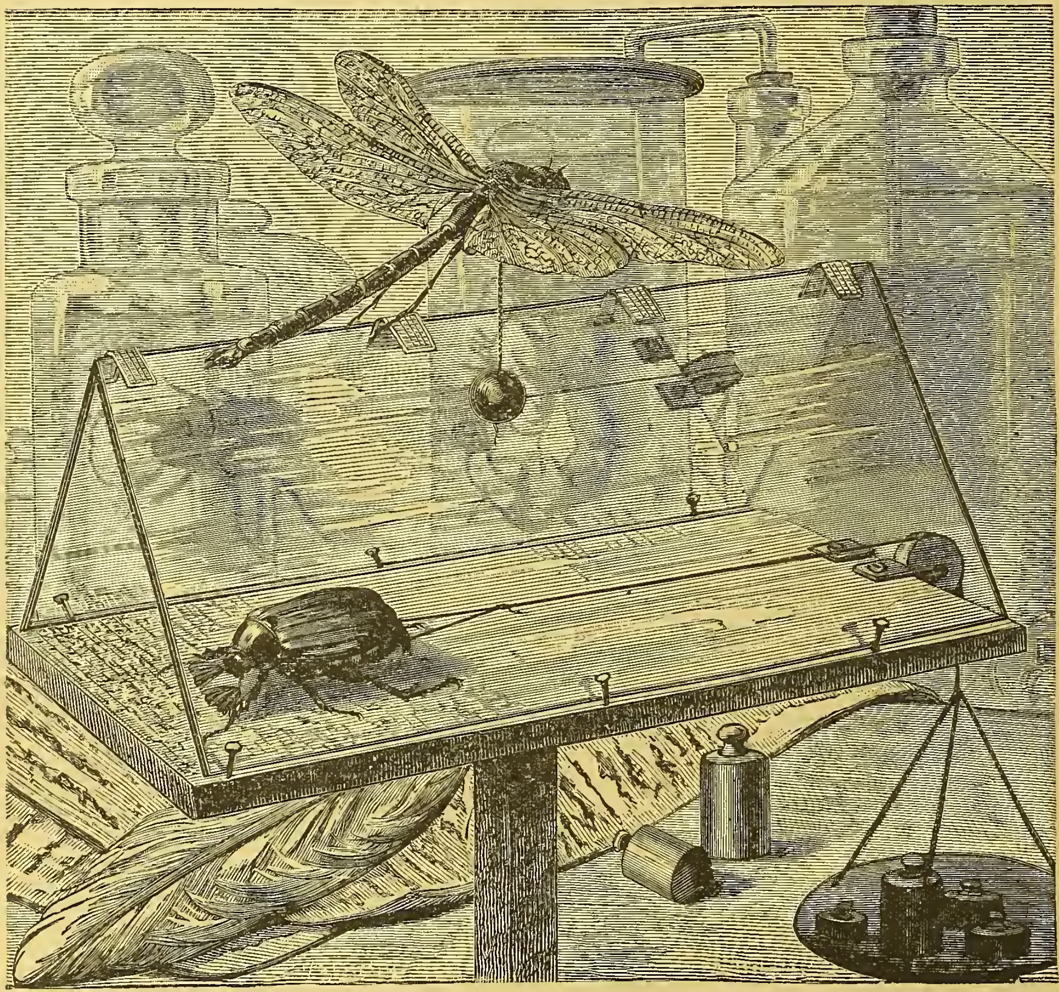
IN speaking of any one who shows unusual strength in muscular exertion, or in bearing up against long-continued fatigue, we are apt to describe him as being " strong as a horse," or as an elephant, or as a lion ; always comparing him to some creature which from its size is calculated to give the idea of immense power. If instead of likening him to one of these beasts we were to say that he was strong as a cockchafer, or as a bee, we should be exposed to ridicule, or the charge of ironical and rude banter. But as a matter of fact, in thus endeavouring to find a parallel in the insect world for the abnormal muscular power exhibited, we should be paying our strong friend a higher compliment than if we compared him to one of the aforesaid vertebrate animals, for it has been found by careful experiment that in the life on our globe, with few exceptions, the rule prevails that the smaller the creature the greater the effective force. In other words, muscular force is in inverse ratio to size.

How many men have lost their lives in the vain attempt to fly by means of attached wings, like those of a bird ! A little reflection will show that they failed from the want of that muscular power which is so enormously developed in the breast of a bird. We are all familiar with the appearance of a fowl when it comes to the dinner-table—the pectoral, or breast muscles, being so much developed as to extend nearly the entire length of the body. It is clear that if men were furnished with such power they might soon devise the means for flight. Without giving any attention to these considerations, people are apt to imagine that because little insignificant insects are able to fly about with the greatest ease, man should, with his knowledge of mechanics, be able to do the same. They altogether lose sight of the fact that insects, in proportion to their small size, are gifted with far greater muscular power than we can boast of. The common flea, for instance, has been shown by experiment to be capable of jumping two hundred times its own height. Now suppose a man six feet high were endowed with proportionate power, why, he would be able at one bound to leap over a building three times as high as St. Paul's Cathedral. At the same time this is only one way of looking at it; for if we calculate the *weights* which these small creatures have to propel, compared with that of a man, the sum would often come out the other way.

A short time ago some very curious experiments were made by M. Felix Plateau in order to test the muscular force of different creatures. He had observed how the busy ant could drag to her home the remains of some insect far larger than herself; how the horse-fly could rival the pace of the swiftest horse ; and how the common house-fly could keep on the wing—sailing round and round some central point for hours together without showing any signs of fatigue. Some of these experiments, as our illustration indicates, were of the most ingenious kind. We see a dragon-fly burdened with a ball of wax, in order to see what weight it could carry without quickly sinking to the ground. This experiment, tried over and over again with different creatures and varied weights, indicated in its results that insects which expend much power in rapid flight are not capable of bearing much additional weight to that of their own bodies. Some were found which could carry a weight equal to their own ; but as a rule none could fly away with anything heavier than itself.

Another class of experiments were to prove how much these little creatures can drag along when harnessed to waggons filled with weights or, as shown in the cut, how much weight they can lift from the ground. M. Plateau found that a cockchafer can draw fourteen times its own weight, and that a bee can draw twenty times its own weight. From this he argues—from calculations which we need not quote—that a cockchafer is, weight for weight, twenty-one times stronger than a horse, and a bee thirty times stronger than one.

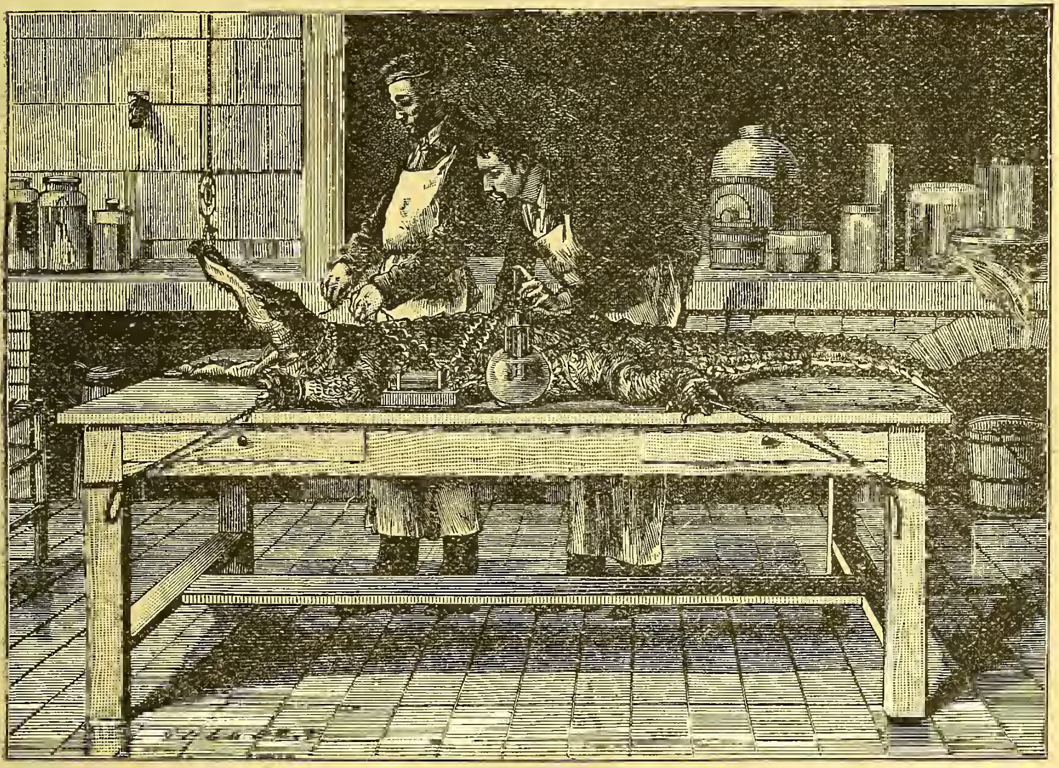
Researches of a somewhat similar nature, but with a very different class of subjects, were made by another Frenchman, M. Paul Bert. We have all heard of the proverbial "bull in a china shop;" but that instance of "matter in the wrong place" is certainly matched by the introduction of a large crocodile to a chemical laboratory. M. Bert having received a consignment of ten of these unwieldy creatures, some of them ten feet long, and weighing 154 lb., proceeded to experiment upon them, with a view to finding out the power developed in the snap of those terrific jaws. A glance at the picture will show how the ferocious brute was tied down, a martyr to science, on the operating-table. His four limbs and his tail were tightly secured. His lower jaw was also firmly tied down. His upper jaw was fastened by a cord to a beam in the ceiling of the room, and interposed just above the creature's snout was a dynamometer. This instrument is familiar to every one, for in a modified form we often see it at places of public resort. There it takes the form of a dial with a pointer, and a handle above it. On payment of a penny any one can test his strength by pulling at this handle, when the pointer indicates the muscular force exerted.



PLATEAU'S EXPERIMENTS WITH INSECTS.

In the case of the bound crocodile the dynamometer was so arranged that directly the creature endeavoured to close his jaws, the pull upon the instrument would show the force expended in the attempt.

To make the reptile interest himself so far in the experiment as to close his mouth when required to do so, a little gentle persuasion was necessary. This was provided by the stimulus afforded by a slight electric shock, which not only was calculated to anger the subject, and therefore to make him snap his teeth, but also acted upon the muscles of the the creature's jaw, and that to show a true result it should have been nearer the muscles acting upon the jaw. It also appears that the reptiles experimented upon were fatigued with their journey, and in very different condition from crocodiles in their natural haunts. A dog, experimented upon in the same manner, showed that weight for weight its muscular power was less than that of the crocodile. Any one who has heard a dog cracking thick bones with his teeth as if they were biscuits must acknowledge that human beings are far behind so far as strength of jaw is concerned.



EXPERIMENT TO TEST THE MUSCULAR FORCE OF A CROCODILE'S JAW.

jaw so as to compel them to act. Referring once more to the picture, we see that one operator is about to apply the wires to the crocodile's head, while the other has his finger upon a bichromate battery, ready to put it in action by the depression of a knob. Connected with the battery is a small induction-coil—seen on the left-hand side—to give the necessary intensity to the electric current.

It was found from this curious experiment that a crocodile weighing 120 lb. exerted a force of 308 lb. in closing his jaw. The results obtained were not considered conclusive, for it is clear that from the position of the cord bearing the dynamometer it was really at the end of a long lever formed by

DERANGEMENTS OF VISION.

Some remarkable cases of derangement of vision are recorded in medical annals. The following was communicated to a collection before us by Dr. Otto, Professor of Medicine in the University of Copenhagen. In the February of 1837, a labourer had a severe fall upon the ice and was removed in an insensible condition to his home. Returning to consciousness, he complained of a slight pain in the right super-orbital region, where the blow caused a tumour to arise equal in size to a closed fist. Both the pain and swelling disappeared in two days, and on the fourth day he returned to his work. But he soon found himself unable to calculate distances, tumbling over things which seemed to be some distance from him, and omitting to descend steps down which he fell because he thought he had not reached them. An object within a foot of him appeared to be six feet or more away, and a man forty paces off had the appearance of being distant about a quarter of a German mile. Colour and form he perceived accurately enough in objects which he believed he was near, but those which he was actually near, but which he conceived to be distant, had their forms less distinct and their colours faint. By closing the left eye objects were made to appear, as they actually were, near or distant; but they retreated immediately when he opened it, and after looking at them for some time their outlines became doubled, worm-like spectra began to appear with moving lines, and his ideas became strangely confused. At the same time he experienced a tingling in the ears, and grew giddy. Closing the left eye immediately removed such uncomfortable effects. The only outward sign of deranged vision was a slight squint in the left eye when it was turned upwards. His sight was worse in dull and heavy than it was in bright, fine weather. A curious sensation of hollowness in the right side of the head arose when he made a false step. His health was otherwise perfect. Dr. Fleischam, of Erlangen, attempted to explain the case in *Hufeland's Medical Journal*, of July, 1838, but with very little success. The poor fellow was long under medical treatment without benefiting by it.

Lucifuga is a curious form of sight derangement, the persons suffering from which are unable to see except at night or when in deep shade. Two instances of this extraordinary disease were observed in 1789, in prisoners liberated from the Bastile, when it was attributed to the years that they had passed in the darkness of their dungeons. Ramazzini describes some cases of it which he met with among the peasantry of Italy, due, however, in his opinion, to the other extreme, that of being always in too bright a light, and consequent debilitation of the iris with over-excitement of the retina. Those suffering from it, he says, were unable to find their way through the fields in the glare of daylight, although they could see perfectly during the night. The disease was cured in their case by remaining excluded from daylight for a few weeks. Curiously enough another disease of the eye, called by medical men "day-sight," has been also attributed to excess of light, although its effect is the direct reverse of the above, sufferers from it being unable to see when the light begins to lose power. Hens are subject to this, and in the twilight are unable to pick up their food, hence the complaint is sometimes called "hen-blindness." Dr. Heberden describes a very singular case of this species of affection. "A man about forty years old had, in the spring, a tertian fever, for which he took too small a quantity of bark, so that the returns of it were weakened without being removed. Three days after his last fit, being then employed on board a ship in the river, he observed at sunsetting that all objects began to look blue, which blueness gradually thickened into a cloud; and not long after he became so blind as hardly to perceive the light of a candle. The next morning about sunrising his sight was restored as perfectly as ever. When the next evening came he lost his sight again in the same manner, and this continued for twelve days. He then came ashore, where the disorder of his eyes gradually abated, and in three days was entirely gone. A month after he went on board another ship, and after three days' stay in it the night-blindness returned as before, and lasted all the time of his remaining in the ship, which was nine nights. He then left the ship, and while he was on land his blindness did not return. Some little time after he went into another ship, in which he continued for ten days, during which time the blindness returned only two nights, and never afterwards." In addition we learn from another medical source that this patient had previously suffered from the use of lead, which it was thought may have been connected with his mysterious malady.

Dr. Heberden mentions also another extraordinary case of defective vision in the case of an old lady, lodging on the east coast of Kent, in a house commanding a view of the sea, and exposed to the full glare of the sun. Her window-curtains were white, and added intensely to the strong light. After being there about ten days, one evening when the sun was setting she noticed that the clouds were curiously fringed with red, which colour gradually overspread every other object, the lightest most thickly. This lasted until sunrise on the following morning, when, as in the other case, her sight was restored apparently unimpaired. This alternation of sound and morbid sight prevailed while she occupied the same lodging, but suddenly disappeared ten days after she had removed.

The author of "Curiosities of Medical Experience" says, "I had a patient in Lisbon who fancied that all the horses he saw carried horns, or extensive antlers. A young lady whom I attended beheld every one of a gigantic height." Dr. Priestley mentions five brothers and two sisters, all adults, whose vision was curiously defective. One could not perceive colours, another perceived them imperfectly, a third only recognised them as light or dark, and so on. Colour-blindness, however, is well known, and in one form or other so common as not to fall within the scope of this article.

THE ELECTRIC LIGHT.

If we would trace the brilliant light which is now becoming so common in our streets and large buildings to its birthplace, we must go back to the year 1809, and watch in imagination an experiment going forward in the laboratory of the Royal Institution. We see arranged there a huge battery, consisting of 200 clumsy-looking vessels, packed with plates of metal, and giving off a visible vapour from the action of contained acids. The cells are all connected with one another, and the two terminal wires from them are held by a grave, thoughtful-looking experimenter, who is busy attaching to each terminal a stick of charcoal (Fig. 1). When that is done he brings the charcoal sticks gradually together, until they touch. Upon once more separating them a brilliant light seems to spring between them, and to cover a space of about four inches in an arch-like form. The experimenter then introduces into this arch of light pieces of platinum—the most infusible of metals—fragments of lime, magnesia, quartz, and all the most refractory substances he can think of. They all melt like wax in the flame of a common candle. The operator notes with extreme interest that this wonderful light—the like of which he has never before seen—is quite different from ordinary combustion, for it is independent of air. This experimenter was Mr.—afterwards Sir Humphry—Davy.

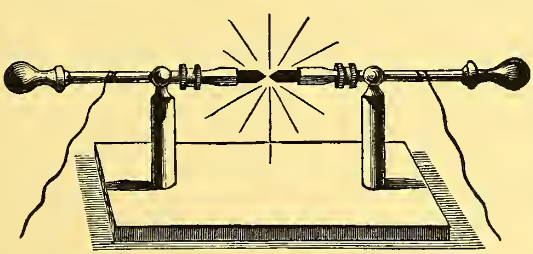


Fig. 1.—THE VOLTAIC ARC.

Davy's experimental light did not create much general interest. The battery was not only so crude in structure that its power would soon depart, but it was in those days of little electrical knowledge a very expensive thing to build up. The improved batteries of Bunsen and Grove, coming forty years later, rendered the production of the electric light a comparatively easy matter, and in an experimental form it was used at most lecture-halls in the kingdom. But before the advent of the new batteries, Faraday had made his grand discovery of magneto-electric induction, which, as we have pointed out in a former article, offered a new source of electricity, and eventually led to the construction of the modern dynamo machine.

It will be seen from Davy's experiment that no light occurs until the carbons touch and have been again separated, when the arch—or arc, as we call it now—is established between them. If from any irregularity of the carbon points (we may here mention that charcoal has long given place to a coke-like carbon, either obtained direct from the gas-retorts or manufactured specially for electric uses) the light is extinguished, and cannot again be established unless the carbons are once more brought into contact. Secondly, the carbons gradually waste away, so that they must constantly be moved forward towards one another; and thirdly, one carbon, the positive one, consumes far more rapidly than the other one. This must be the case with a battery current, and with the current from any dynamo-machine giving, like a battery, a continuous current. Alternate current machines, on the other hand, where the current is being continually reversed, would cause the carbons to waste equally. We shall presently see that in one form of electric light such a machine is indispensable.

We may then sum up the requirements of an electric arc lamp, or regulator, in the following terms. The carbons must touch and be automatically separated whenever the circuit is established, and they must be moved towards one another at different rates of speed. When these conditions came to be understood, inventors were not slow in contriving regulators which would fulfil them. In most regulators we find a similarity of construction. Two pencils of carbon are placed vertically, and made to approach one another by wheel-work or clockwork. Most arc lamps take this form even up to the present day. But it must not be supposed that inventors have slavishly followed one model. A glance at the records of our patent office—to say nothing of the specifications abroad—will show those curious in such matters that electric carbons have at different times assumed every imaginable form and position with regard to one another. Nor has carbon itself always been the material chosen for these terminal points between which the electric arc is to play, but as it is now universally used, we may consider it a good example of the survival of the fittest.

In 1844, when improved batteries came to be invented, the first serviceable lamp or regulator—that of Foucault—was devised. To him the credit of bringing gas-retort carbon into use instead of soft charcoal must also be given. His regulator was of simple construction, and the carbons were held vertically, but it required a certain amount of help to keep it in action. In 1848, more than one inventor hit upon the expedient of causing the current itself to regulate the distance between the carbons, and in nearly every form of arc regulator invented since that date this plan has been adopted by means of an attached electro-magnet. The first lamp of this sort to come into general use was that of Duboscq, shown in Fig. 2. The carbon poles are moved up and down by the separate racks *a b*, one worked by the small wheel E, and the other by the wheel F of twice the diameter, both working on the same axle, and moving together by friction only. This provides for the double wasting of one pole, while yet either carbon can be raised or lowered separately by the handle, D, and a similar one on the other side of the instrument. The whole is driven by clockwork, regulated by the fan, G, but which is stopped while the current passes properly in the following manner. The current passes through the coil, L, the core of which when magnetised draws down the iron ring, H, which by a lever raises the rod, K, so as to catch in the teeth of a wheel under the fan and so stop the clock. When the current fails the clockwork operates, and the poles slowly approach till the current is re-established, when the ring H is again drawn down, at once stopping the clock and separating the poles sufficiently to give a brilliant light. After the Duboscq lamp came those of Siemens and Serrin. The last named is perhaps the most reliable of any; and those who have tried most fall back upon the Serrin as the most trustworthy and constant in its behaviour. Unfortunately, being of complicated construction, its expense is a great obstacle to its use, a single lamp costing nearly twenty pounds.

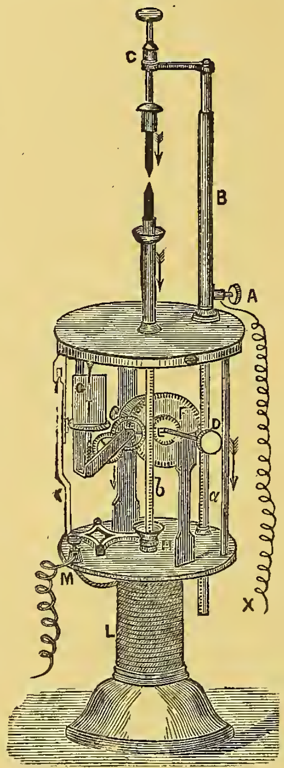


Fig. 2.—DUBOSCQ LAMP.

In the year 1877, reports came to hand of the invention, by a Russian engineer named Jablochkoff, of a lamp that could be produced for a few shillings. It quickly earned the name of the electric candle, because it stands upright, and slowly consumes from top to bottom, until it is burnt out. The inventor must certainly be credited with wonderful ingenuity, if it is only on account of his finding a position for two carbon rods which had not previously been patented. In the Jablochkoff candle these rods, instead of being placed one above the other, stand side by side, not touching, but separated by a strip of non-conducting material—china clay or plaster of Paris, for instance (Fig. 3). The two carbons, with their plaster partition, are manufactured so that they form one piece, the carbons being bridged over at the top, with a junction piece of graphite. At the lower part of the "candle" the two carbons terminate in brass tubes, which can be readily fixed upon terminals placed for them in the lamp in which they are used. In action the current traverses the rods, quickly destroys the graphite connection at the top, and an arc light is established between them. As the carbons waste away the plaster partition is vitrified, so that it also wastes at the same rate. In this way the "candle" in about one hour and a half is burnt out, to give place to a second, a third, and fourth placed in the same lantern, and brought automatically into circuit one after the other. If this form of regulator were attached to a battery, or to a dynamo machine giving a continuous current, one carbon would soon waste below the level of the other, and the maintenance of the arc would become impossible. So for the Jablochkoff candle machines arranged to give alternating currents are used, that both carbons may waste at the same speed. The wonderful exhibition of electric lamps on the bridges and the Thames Embankment in 1882–3 was due to the Jablochkoff system, the necessary current being furnished by Gramme machines, placed in a building close to Charing Cross railway-bridge. When the Jablochkoff candle was first tried in London, the promoters had to depend upon the services of an antiquated machine of the "Alliance" type, for no modern dynamo would furnish anything

Fig. 3.

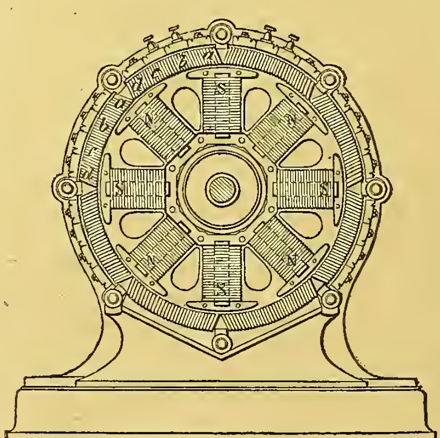


Fig. 4.—GRAMME ALTERNATE CURRENT MACHINE.

but a continuous current. But the success obtained seemed so promising, that M. Gramme produced a new machine on purpose to furnish the alternating current required. This machine is shown in section at Fig. 4. The Gramme ring is still retained, but it is stationary, whilst the magnets, eight in number, are caused to rotate upon a central shaft. The coils, *a b c d*, on the ring are so placed that each section of the wire is wound in an opposite direction to its fellow. The coils of the electro-magnets show also, by the lettering N S, that alternate poles are presented towards the ring. For exciting the magnets, an ordinary Gramme machine is used, and at the Embankment Station the two forms are seen side by side, with their leather bands over the shaft which supplies both with motion. This machine is also known as the distributor, for it fulfils the office of splitting up a main current so that it may feed several circuits.

While the Jablochkoff system represents a wonderful simplicity when compared with the intricate details of a Serrin or Siemens lamp, we must remember that although the first cost is less, the expense in the matter of "candles" must be considerable. Then, again, one globe cannot well be made to contain more than four candles, which will only afford light for six hours—a very short allowance for a long winter's night. If one "candle" on a circuit by any means becomes extinguished, the rest on that circuit follow suit, and they cannot be again put into action until the two carbon points are momentarily bridged over.

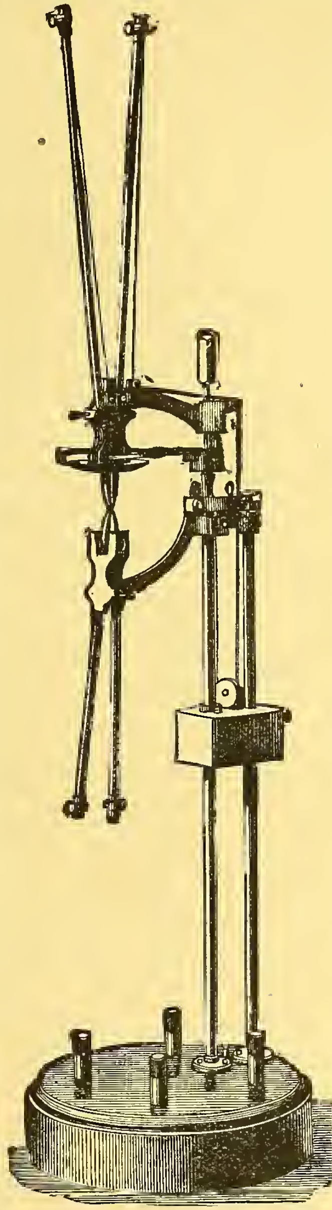


Fig. 5.—RAPIEFF LAMP.

A still more recent advance is represented by another Russian invention—the regulator of Rapieff, shown in Fig. 5. This regulator has been in use in the composing-room and offices of the *Times* at Printing House Square, where its brilliant light and steadiness gave much satisfaction. Here, instead of two carbon rods, we have four all pointing to a common centre, where the light is produced. Each carbon has attached to it a fine cord in connection with a weight, so that they are urged forward as their points become consumed. An electro-magnet, concealed in the stand of the lamps, causes the carbons to meet, should they from any cause cease to give light, and a knob at the side regulates the distance separating them from one another. The advantages claimed for this form of regulator are—1. The production of the current by any description of dynamo machine, whether it give a continuous or an alternate current; 2. The complete independence of each lamp, the possibility of using several of them in one circuit, and the very long life of the carbons employed; and 3. The great ease with which carbons can be replaced by fresh ones without extinguishing the light—a change which can be made by an unskilled hand. M. Rapieff has also contrived a "candle" of the Jablochkoff type, without the intervening plaster. In other words, he places two carbon rods side by side and about a quarter of an inch apart. So long as no current passes, their points lean towards one another, and they touch; but directly the circuit is established, they fly apart, and the arc of light burns brilliantly between them. There is something extremely canny in this idea of re-patenting the "candle" without its most distinctive feature. It is only due to Mr. Wilde, of Manchester, to say that he was the first in the field with a contrivance of the kind, and showed that the carbons can be more economically used when merely separated by a strip of air.

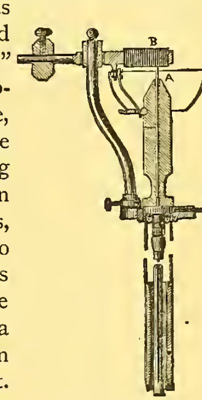


Fig. 6.

M. Werdermann made another new departure when he introduced an arc lamp, in which the negative carbon took the form of a convex or flat block, B, whilst the positive in contact with it was of the ordinary pencil shape, A (Fig. 6). By simple means the one was constantly pressed against the other, so that, in addition to a luminous arc, the positive carbon gave out an extra amount of light, due to its own incandescence. The light given by this system was soft, perfectly steady, and very agreeable ; it was also capable of great subdivision. But it required a great expenditure of power. M. Werdermann has more recently produced a lamp of modified form, which gives far better results than the early model described.

A still better known arc lamp is that of F. C. Brush, whose patents not only cover a machine, but a lamp, and specially-made carbons for use in that lamp. To the extreme purity of this carbon may probably be traced the very steady light afforded by the Brush system, which is now in use in nearly every country. The regulator itself has the old form, with the carbons placed vertically one above the other, but it is extremely simple, appearing to be little more than an iron frame. It has no clockwork or other elaborate mechanism, and is independent of other lamps on the same circuit : which means that if one lamp of twenty be extinguished, the other nineteen will continue to glow, but with slightly-increased brilliancy. The various other forms of arc lamps now competing for public favour are too numerous to mention, and every electrical exhibition brings out some fresh one. Those of Crompton and Pilsen are well known.

There are other familiar names in connection with electric illumination : Edison in America and Swan in England, to wit. But they are identified, not with the arc form of light, but with its yokefellow, known as the "incandescent lamp." To a consideration of this important phase of the subject we shall devote a separate article.

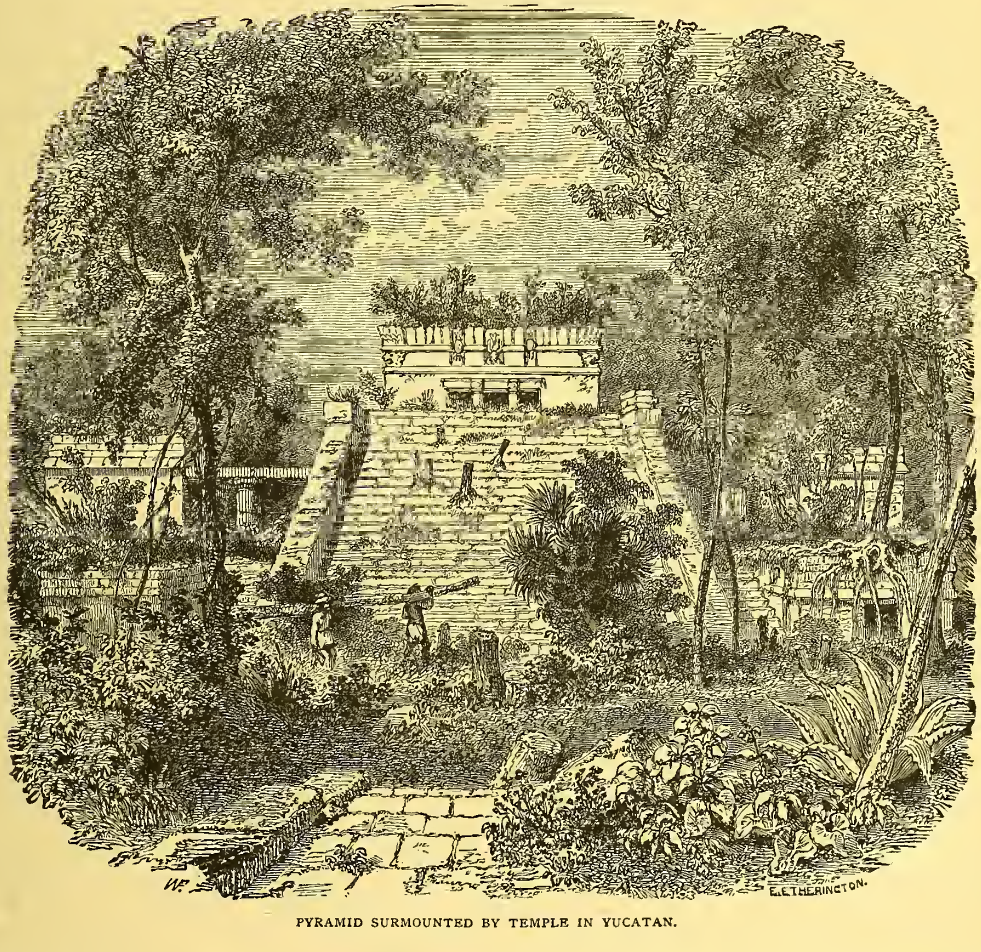
A REMARKABLE LIFE.

SOME years since a weekly illustrated paper published an excellent portrait, from a photograph, of John Gilliatt, of Brigg, in Lincolnshire, taken by Mr. Empringham, the master of the Union. He was then over a hundred years of age, and so hale and hearty that he seemed likely to last some years longer. He was born on Plough Monday in 1761, as he asserted. In his early manhood he fell, as many other unfortunates did, into the hands of the press-gang, and served, as was easily proved, on board his Majesty's ships *Dictator*, *Trusty*, and *Formidable*. In 1791 he enlisted into the 7th Dragoons, and endured all the fearful hardships of the campaign of 1793 in Holland under the Duke of York. On one occasion, fighting single-handed against a French trooper, he lost the middle finger of his left hand. At another time he used to tell how the men of his regiment traded upon the ignorance of the country people by passing their regimental buttons off as English money. When this was found out, and the men paraded, scarcely a soldier had his complete set of buttons. The Duke, half angrily, half jocularly, shook his fist at them, and called them a rascally lot, saying he believed that they were everything that was bad, except cowards. Being discharged, he went home and lived with his parents at Caistor, in Lincolnshire, until that place was invaded by the press-gang, and he was driven away by them to enlist in the 3rd Regiment of Guards, in which he was often on sentinel duty outside the palace, and was several times addressed with unaffected familiarity by King George III. and Queen Charlotte.

When the rebellion of '98 broke out in Ireland he was there with his regiment, and actually witnessed the wonderful ignorance and daring of a rebel who thrust his wig into the mouth of the cannon, crying, " Come on, me boys, I've spiked him," and was at once blown into atoms. Maxwell mentions the fact in his History, and one of the late George Cruikshank's most powerful etchings represented the mad action. He was with the troops who fought and endured so desperately against the French in Egypt, and well remembered the indomitable pluck and daring of the landing from boats in the front of the enemy, when shot and shell ploughed up the sea about them into one continuous sheet of foam. While landing and swiftly forming into line under fire, he was knocked down by a musket-ball, which tore open his scalp, but, as the old veteran would say when telling the exciting story, " I jumped up and fired twenty-five rounds after that." He fought in that awful struggle when the French had stolen upon them through the mist, and were slashing and cutting them down as they fought in twos and threes back to back amongst the tents. There, too, he saw Abercromby receive his death-wound, and would tell, with tears in his dim old eyes, how Sir Ralph, remounting with his white hair bare and the blood running freely from him, cried out, "Stand firm, my lads, and I shall die happy." How firmly they stood and how well they fought (with stones when their ammunition was exhausted) and at last drove their foes before them, history will tell. He was invalided and sent home, after being nearly blinded by the heat and sand. He was discharged in 1801, and his paper then stated that he was forty years of age. He next returned to his old trade, that of a fellmonger, and was in the employ of Mr. Harrison, of Sleaford, forty-two years. He married and had two children, who died young. When too old for work he had no refuge but the Union, in which he lived eleven years, after which time he received a pension, not from the State, but from the private purse of the Earls of Yarborough. When in his prime he stood five feet eight inches ; in old age he did not measure more than five feet two inches. He always led a healthy, sober, industrious life, and was very proud of his medals.

THE ANCIENT SCULPTURES OF CENTRAL AMERICA.

STORIES of the splendour and solidity of the towns of Central America were lavishly spread by the Spanish soldiers of Cortes and of Pizarro, but their accounts were vague, and perhaps contradictory; and it is, therefore, hardly to be wondered at that between the interstices of the walls or of the magnificent flights of steps, have eventually forced the stones in their vicinity far from their positions, bringing about a state of desolation greater than could have been produced by the hand of time alone. Nevertheless, these ruins remain in sufficient completeness to prove that when erected they must have possessed striking majesty; and, as one of

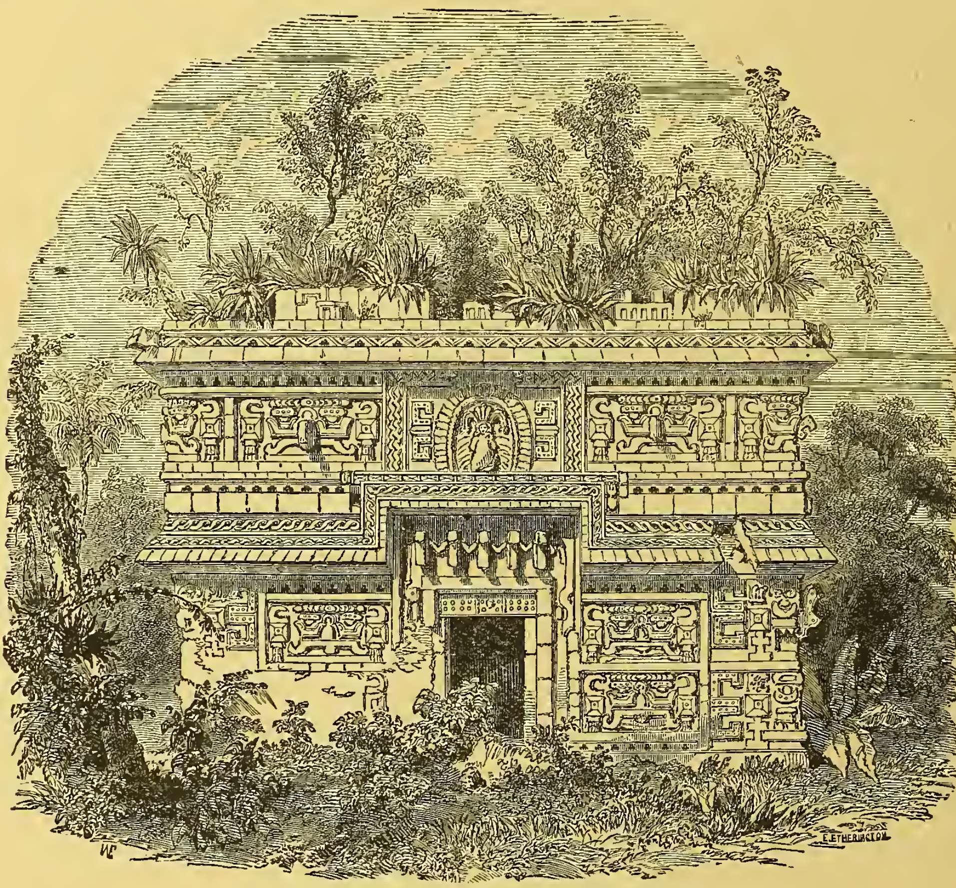


PYRAMID SURMOUNTED BY TEMPLE IN YUCATAN.

Dr. Robertson, in his "History of America," should have concluded that these reports were wilful fabrications, and that no such sculptured cities ever existed as had been described. Possibly there was some correctness in this conclusion; for though, undoubtedly, the ruins of vast buildings are yet to be seen in Mexico, Peru, Yucatan, and other parts of South and Central America, it is, nevertheless, far from improbable that many, though certainly not all, had been deserted long ere the Spaniards set a foot upon the soil. The ruins are buried, as they have probably been for centuries, beneath dense forests of timber; and often huge trees, springing at first their earliest explorers observed, some are "in workmanship equal to the finest monuments of the Egyptians."

Indeed, some of these American monuments bear a curious resemblance to those of Egypt. The severity of the main lines of their edifices, the grand and impassive character of many of their images, remind us most forcibly of the sculptures of ancient Egypt; and it has even been supposed that America was, in fact, colonised by a branch of that great Cyclopian family whence was derived the race of Shepherd Kings who at one time ruled the destinies of the Egyptians. By those holding this opinion, a wonderful inscription, discovered engraved upon a rock in Massachusetts, and which closely resembles the Phœnician character, is adduced as almost positive proof of this emigration. The fact that maize occurs in North Africa is also curious and significant.

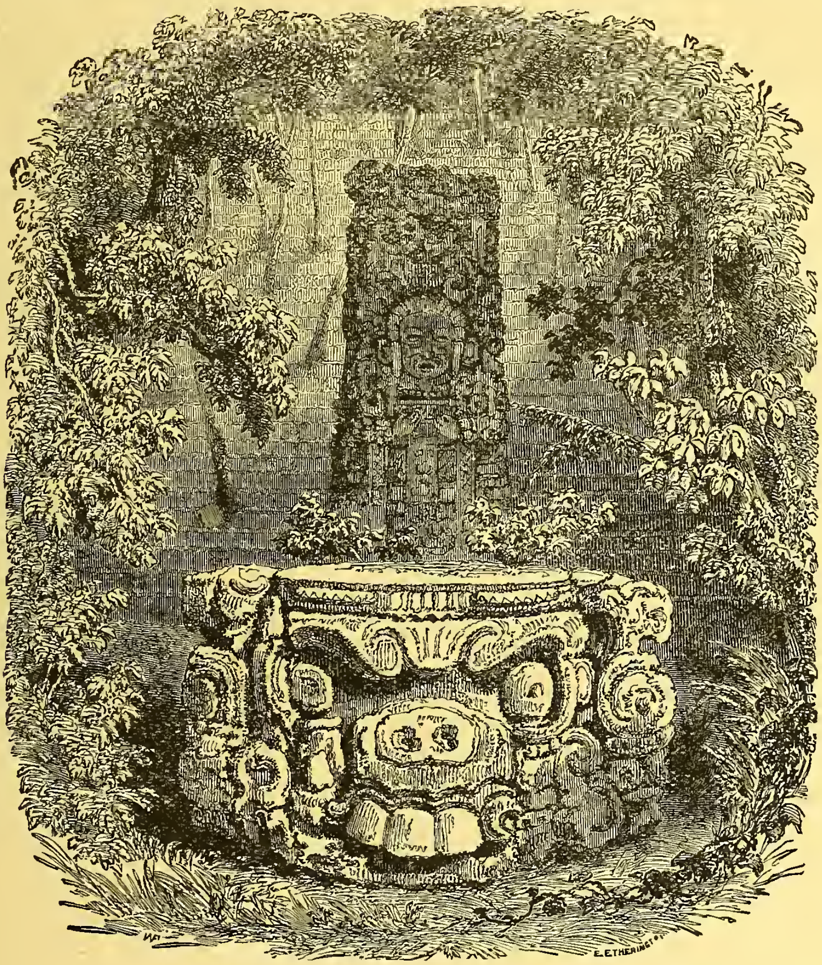
It is remarkable that at the time of the discovery of Mexico by the Spaniards the natives were entirely ignorant of the use of metal, and were dependent upon flint for their arrow and javelin heads, and for their other implements. It has, however, been conclusively proved, by the discovery of many well-fashioned implements, that the ancient inhabitants of these now ruined cities of Central America were well acquainted with the use of copper, and that they even tempered this metal to considerable hardness by a judicious admixture of tin. The remains of ancient copper mines have also been discovered in the neighbourhood of Lake Superior. How such an art, when once acquired, should have so totally disappeared, it is difficult to conceive, but not more difficult than to account for the utter extinction of a race of people so highly cultivated as were these strange builders. It has been supposed that, enervated by a high, but ultimately unprogressive civilisation, the dwellers in the cities became at length the easy victims of immigrating barbarians, and were, in no long space of time, utterly exterminated by warlike hordes from the north. It has also been surmised that their culture, having reached a certain point, again gradually declined, until the remnant of the populations forsook the cities which they were no longer able to maintain, and merged in the surrounding tribes ; but this view is hardly supported by the fact that the people now inhabiting Central America are utterly without traditions of such a former state. The fact would seem to be, however, that the present barbarous Indians are the descendants of the original city-builders, but that they have become degraded to their present level by the persistent and systematic oppression of their Spanish conquerors, whose aim, as they acknowledged, was to eradicate from the minds of the



TEMPLE AT CHICHIN-ITZA.

natives every recollection of the original greatness of their people. However this may be, the inhabitants of all these old cities have now completely disappeared, leaving not a vestige of authentic history, or even of less reliable tradition, to tell the story either of their origin or of their decay; and our knowledge of them is derived alone from the gracefully-adorned temples, the people themselves were content to live in the most fragile of huts, which have long ago disappeared, leaving not a trace behind.

The palaces and temples are mostly, if not always, erected upon "truncated pyramids," often of enormous extent, and the labour of constructing



IDOL AND ALTAR AT COPAN, IN GUATEMALA.

their architecture, and from the sculptures which they have left to us.

Though usually referred to as ruined *cities*, it should be observed that all the edifices of which the remains now exist are of the most sumptuous and magnificent character, and could only have served as *temples* or as *palaces*. Not a vestige of any less imposing structure remains; and it must be supposed that while the kings or rulers were housed in these stately mansions, and the religious worship, with all its hideous concomitants of human sacrifices and cannibalism, was conducted within which is almost incalculable. Generally these pyramidal structures were in the form of terraces rising one upon another, and were mounted by massive flights of stone steps, many of which are still standing, almost as perfect as when first laid down centuries ago. In the architecture and sculpture, the utter dissimilarity to anything in the Old World is what first strikes the beholder. As has been said, there is much resemblance in "feeling" to the Egyptian style, but this is neither frequent nor striking in detail. The general effect of some of the numerous bas-reliefs is occasionally Oriental;

but a closer and more extended examination of the ruins removes this impression, and at last the whole character of the remains assumes a quaint singularity, with which no parallel is to be met in any other part of the world.

The American builders seem to have been quite without a knowledge of the true arch, though they were accustomed to contract the upper part of a doorway or ceiling by laying the successive courses of stone jutting towards the centre, and finally completing the false arch by laying a single broad slab of stone upon the top. In the absence of the arch, their doorways and windows were, however, generally square, the top being bridged over by a single large stone, often of great bulk. This style necessarily imparted to their architecture a horizontal character, similar to that adopted by the Egyptians, though the surfaces of the buildings were generally covered with quaint sculptures, which gave a lightness to the effect which they would otherwise lack. The sculptured ornaments generally offer a most marked contrast to anything to be seen in other countries. Occasionally, indeed, a line of zig-zags, or of small circles, formed by the interlacing of two continuous bands, will remind us of the conventional ornamentation of the East; but such familiar patterns are the exception, and serve rather to emphasise the strangeness of the accompanying designs. Amongst these, grotesque human heads, probably representations of heathen deities, decorated with still more grotesque head-dresses, are very numerous; while one of the most favoured decorations is a row of alternate death's-heads and cross-bones, with which the fronts of many of the flights of steps were adorned. As a rule, the walls of the palaces are of solid masonry, decorated, or not, with sculpture which has no part in the construction of the edifice, and surmounted by a kind of "frieze," sometimes several feet in depth, which projects some distance beyond the lower walls of the building, and is usually elaborately carved, and enriched by innumerable grotesque projections. Amongst these is one to which the name of "elephant's trunk" has been applied, and the curve which this favourite ornament assumes certainly justifies the name. Starting from the wall in which its base is embedded, it first projects in an almost horizontal line, then curves gently downwards, and again re-curves upwards, thus having exactly the form of the elephant's trunk when in the act of bellowing. This is very remarkable in connection with the "elephant mounds" and other representations of the animal, which have been referred to in a former article (page 84), and with the fossil remains of the animal which have been discovered.

From the fact that immense stone annulets were occasionally suspended from somewhat similar projections in some of the buildings, it is possible that these ornaments may have been intended as hooks for a similar purpose, but in the absence of a single recorded instance of such an occurrence, it would be hardly safe to assume that such was the case.

Though, as has been said, the surface of these American buildings was generally plain and massive, yet some few instances of the use of pillars, or pilasters, have been met with, and though they are generally of clumsy and somewhat heavy appearance, yet occasionally they have been employed to give an airy gracefulness to the exterior which compares favourably with the more sombre character of the more usual style. In one case these pillars are slender and symmetrical, rising from a slightly expanded base, and terminating in a similar expansion above, while between each pair of pillars is a row of lozenges, which add to the plain, but pleasing, lightness of the whole.

But we must turn from the architecture to consider the sculptured beauties of these Indian temples. There would seem to have existed, side by side, two schools of art—the hieratic and the profane. The former, though not without skill and some rude artistic merit, maintains a certain uniformity of quality, which was probably the conventional result of religious influences. The idols are almost all upon one plan, and the sculpture upon them differs little in character, however much it may in detail. The front generally represents a human figure, which occupies about two-thirds of the length of the stone, and is covered with grotesque carvings, which perhaps represent the folds and adjuncts of a sacred robe, while above the head is generally a group of carvings, without apparently any object but ornament, though occasionally a second human head makes its appearance amongst them. On the back and sides of these idols—which, except in front, are without definite form—are carved innumerable figures and patterns, which are sometimes perhaps genuine hieroglyphics, but more often what are termed picture-writings. Besides these idols, there are, however, other representations of the heathen gods, of a massive solidity, strongly resembling some of the sculptures of Egypt, notable amongst which is a figure of what has been deemed the Indian Bacchus—Tezcatzoncatl, or Izquitecatl—which was found only a few years ago at Chichin Itza, in Yucatan. This figure, like others which have been recently described, is reclining upon its back, the knees being bent and the soles of the feet resting upon the ground, while between the hands rests a vessel, supposed to represent a wine-bowl. It is probably of comparatively modern date, and has been first rough hewed, and afterwards ground smooth with stones, so that there can be little doubt that it belongs to that period when the Yucaticans had lost the art of tempering copper, " and when, as at the period of the conquest, they had arms only of obsidian and other hard stones." Comparatively few specimens of the profane art of the Indians have hitherto come to light, but these seem to be of a character far superior to those inspired by religion. A tiger's head, found at Mitla, has been described as equal to "a European work of art," while a man's head, from Yucatan, "though damaged, would bear comparison for finish and modelling with the works of the ancient Greeks."

It has sometimes been affirmed that the inscriptions of Central America were not true hieroglyphics, but invariably picture-writings. This would, however, hardly seem to be the case. It may sometimes, perhaps, be affirmed that the sculptures are actual representations of important occurrences, though they are quite unintelligible to us at present, but in other cases, as in that of the long line of nearly forty feet of hieroglyphics found in a building at Chichin Itza, there can be little doubt that the figures employed are truly hieroglyphic in character. Excepting here and there a human face in profile, the figures represent nothing comprehensible, and it is with a feeling of despair that American archæologists see these long lines of sculpture, and the innumerable similar characters on tablets, idols, and altars, and yet feel that they are powerless to read the story which is so plainly before their eyes. Nothing has yet been found to throw the first small beam of light upon the meaning of these silent records, and until that apparently hopeless time arrives, it is to be feared that the true history of these long-ruined buildings must remain completely unknown, or at least most imperfectly known to us—perhaps by no means one of the least of the many wonders of the world.

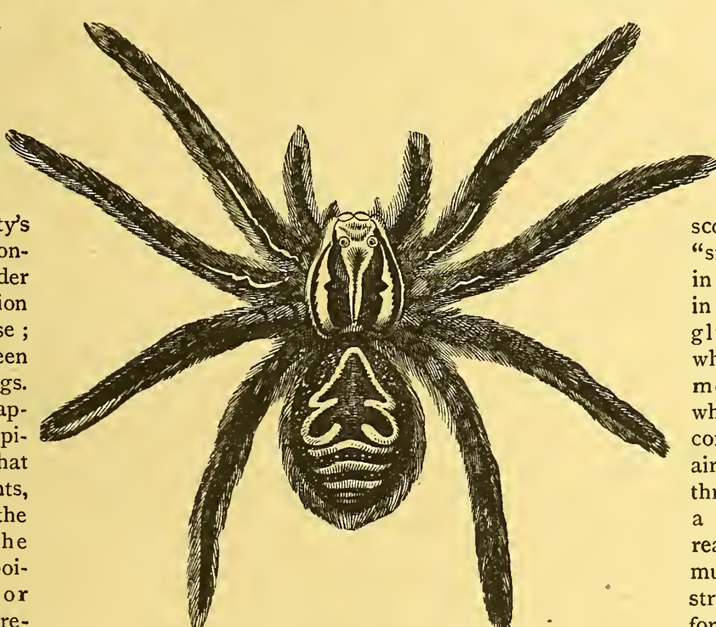
WONDERS OF SPIDER-LIFE.

SPIDERS, mites, and scorpions belong to a class of the "jointed" animals named *Arachnida*. The origin of this name lies in the old classic fable, wherein Arachne, daughter of a Lydian purple-dyer, was believed to have challenged Minerva to a trial of skill in weaving. The goddess, enraged at being challenged by an ordinary mortal, changed Arachne for her audacity into a spider, in which character she, of course, would have every scope for her powers of spinning. Such was the legend. The name *Arachnida* indicates, however, animals which do not weave or spin nets. A scorpion, for instance, is noted for its poison-gland and sting; whilst the mites are most remarkable for their minute size, and for their ravages in our foods, in the furs of stuffed animals, and even in the bodies of other animal forms. But it is easy to show that spiders, mites, and scorpions all agree in certain well-marked characters, and that in the possession of these characters they differ from insects and like animals. An insect, for instance, has only six legs; the spider-tribe have never fewer than eight; and the latter are never winged, although of course many insects (*e.g.*, the ants and fleas) do not possess wings. Spiders, again, have no "feelers," as such, whilst insects have a pair of these organs. In spiders, the feelers are regarded as being represented by a pair of the jaws. Insects breathe by *air-tubes*, that branch everywhere throughout their bodies. Spiders may breathe by such tubes, but, in addition, they possess curious breathing-sacs, to be hereafter noted. In an insect we can discern the head, chest, and abdomen (or tail), all clearly separated one from the other. In spiders, mites, and scorpions, on the other hand, the head and chest are combined to form one region of the body; and precisely the same union of parts is seen in the lobsters and shrimps. It may thus be seen that spiders form a highly distinct group of animals; and if, lastly, we think for a moment of their spinning powers and their many curious habits, we may readily enough find ample reason for the practice of the naturalist in separating them from the insect class.

The first illustration accompanying this article depicts one of the largest species of the spider-class. It is named the Bird Spider (*Mygale avicularia*), from its habit of seizing small birds and of sucking their blood. One species (*Mygale Hentzii*) is described as ranging southwards from Missouri, and it is in the tropical forests of the New World that these curious beings lie in wait for and destroy their prey. The spider-group to which these giants of the spider-race belong, is known by their possessing hairy bodies, and by their having four lung-sacs, and only two pairs of "spinnerets," or weaving-organs. They possess eight "occelli," or simple eyes; for all spiders want the great compound eyes we see in insects. Most of these spiders do not spin a regular web, or net, as is the case with their more familiar brethren; on the contrary, they make holes in the ground, which they line with the silk secretion. *Mygale nidificans*, literally, "the nest-making" Mygale of the West Indies, thus closes its nest-hole by means of a curious lid of earth, which is lined below with silk. It is this group which harbours the "Trap-door Spiders" of the Old World. The "door" often fits the entrance of the pit or nest excavated by the spider in the most accurate manner; and any attempt to raise the lid when the inmate is "at home" is strenuously resisted by the fabricator of the ingenious abode. The Bird-eating Spider of our illustration and its near neighbours inhabit the bark of trees and similar situations, in addition to frequently forming nests in the ground. Some authorities state the number of eggs pro-

THE BIRD SPIDER (*Natural size*).

duced by the females of this species at 1,800 or 2,000, the eggs being encased in a beautifully delicate case of silky material. Mr. Bates, the famous South American traveller, tells us that on one occasion he found two small birds hanging in a damaged web which had been spun across a cleft in a tree. One of the birds was dead, whilst upon the other the great spider was crouched like a lion on its prey. This second bird was still alive when it was first observed by Mr. Bates, but died soon after he took it into his hand to examine it. Mr. Bates also tells us that he saw some Indian children in the Amazon territory leading one of these great spiders about by means of a thread tied to the middle of its body. On more than one occasion, live specimens of these huge spiders have been brought to Europe. One lived for some time in the Zoological Society's Gardens in London. This spider on one occasion killed a mouse; another has been known to kill frogs.



TARANTULA (*Natural size*).

The poison apparatus of the spider-tribe, like that of the serpents, naturally excites the interest of the zoologist. The poison-organs, or "fangs," are represented by a pair of jaws, or "mandibles," which naturalists regard as representing the "feelers" of insects. The terminal joint of the jaw forms a regular "fang," and is perforated by a canal which leads from a poison-gland. Thus, when a spider attacks its victim these "fangs" are plunged into the body, and the poison is thus conveyed into the prey with a fatal effect in the case of flies, and, as we have seen, even of small birds.

Spiders, possessing as they do a large share of cunning and intelligence, and excelling insects as a rule in the complexity of their actions, might naturally be supposed to possess a nervous system of high and specialised nature. We find, accordingly, that such is the case. Instead of the double chain of nerves which, in the insect, stretches along the floor of the body, we find the nerves of spiders to exhibit a high degree of concentration. A great mass of nervous matter lies in the floor of the chest, and from this main centre nerves are supplied to the adjacent parts. The senses are represented much as in insects. Touch is very perfect in these animals, and is subserved by the "pulps," or feelers, connected with the mouth-parts. We may readily enough conceive that in animals which construct dwelling-places of such complexity as the spiders are in the habit of making, the need for a perfect sense of touch would be very great. Organs of hearing are not known to exist in spiders, but simple eyes are developed, as already mentioned.

It is in the spinning powers of spiders, however, that we certainly find their chief characteristic. The weaving-organs, or "spinnerets," are situated at the tip of the spider's body. They consist of little projections, which are perforated by an immense number of minute holes, representing the ends of as many microscopic tubes. The "silk" is secreted in special "glands," in the shape of a glutinous fluid, which becomes more tenacious when brought in contact with the air. Thus the thread with which a spider works in reality consists of multitudes of finer strands, united to form the single filament. As the thread itself is of extreme delicacy, the fineness of the separate threads may be more readily imagined than realised. Very varied are the ways and means which spiders employ in the fixation of the web. The common garden spider (*Epeira diadema*) forms a web which must certainly be ranked among the most interesting specimens of its class. The outermost lines are first fixed, these lines forming the boundaries of the web. Between these lines the radiating cords are next stretched; then, beginning at the centre, the spider attaches a series of short ladder-like threads between the radiating cords, and follows a spiral course in this latter work. The curious fact has been observed that the cross lines are of a wholly different structure from the rest of the cords. They are very elastic, and are, moreover, covered with a glutinous secretion, that doubtless assists the retention of any insect which may be entrapped. In the centre of the net, the spider lies in wait, head downwards, for prey. When the insect is entrapped, it would appear that the spider will weave around it fine threads, which limit its struggles, and which, in the case of large insects, must effectually aid the securing of the prey.

Some species of spiders, instead of making a web, or net, weave their silk secretion into a kind of delicate cloth, with which a kind of tent is made. The water-spiders build a dome-shaped nest, or "bell," below the surface of fresh waters. The air necessary for breathing is obtained from the atmosphere. For ordinary use, and while pursuing its usual avocations in seeking prey, &c., the spider depends upon the air adhering to the hairs on its body, which gives it a silvery appearance under the water; but the nest itself is filled with air by a highly-ingenious process. The spider ascends repeatedly to the surface, and then descends with an actual bubble of air attached to the posterior part of its body and the extremities of its hind legs. On arriving at the nest, the feet discharge the bubble of air into it; and thus in succession bubbles are fetched down, until the stock of air accumulated is sufficient to last the occupant for a greater or less time, or to fill the nest. Few operations of animal-life are more curious than this; nor are there many whose origin is more difficult to account for.

The breathing-organs of all spiders, it may here be fitly explained, consist of peculiar bags, or sacs, called "lung-sacs." Each of these sacs—which may be accompanied by breathing-tubes similar to those found in insects—consists of a bag, within which are contained an immense number of delicate folds, on which the blood-vessels branch. By the multiplication of these folds, a large surface is provided for the aeration or exposure of the blood to the purifying influence of the air admitted to the sacs.

Spiders have played their own part in the production of the myths and superstitions with which the literature of every country abounds. The most famous of the spiders which have figured in such records is the *Tarantula* (*Lycosa tarantula*), a species common in Southern Europe. In Southern Italy the bite of these spiders is still believed to cause a species of madness, of which the chief feature is alleged to be an insane and uncontrollable desire to dance and to contort the body. No evidence is forthcoming that any such effects are now experienced after the bite of these spiders, even supposing, what is by no means likely, that they are given to attack mankind. Probably, on some occasions, their bite may have caused disagreeable symptoms, and around this fact have been woven the mythical tales of the Tarantula's powers; but this topic may perhaps form the subject for another short article.

CELLULOID.

It is next to impossible to point to a single manufacture which has not been either greatly improved or actually originated by modern chemistry. In his laboratory the chemist now and then hits upon an entirely new compound which possesses peculiar properties, or perhaps resembles in appearance another substance of great rarity, or which may be far more expensive to produce. One of the new compounds is Celluloid, which bears so close a resemblance to ivory, that for many purposes it can be used in its place. It can, for instance, be employed for pianoforte keys, ornaments of all kinds, handles of doors, billiard balls, frames, combs, jewellery and fancy goods of all sorts. It can be dyed thoughout its substance so as to imitate malachite, coral, tortoise-shell, &c.; indeed it is difficult to enumerate the many useful purposes to which the new material can be applied. Recently a new employment has been found for it in the manufacture of shirt cuffs and collars, which are subject to the dominion of no laundress, for the wearer has merely to rinse them in water every morning to restore them to their original whiteness.

Celluloid is virtually a mixture of collodion and camphor, but the varied operations necessary before the finished article is produced will show that its manufacture is by no means a simple compounding of two well-known materials. The process of manufacture, as now carried on in Paris, is briefly as follows:—Cigarette paper is soaked in a mixture of nitric and sulphuric acids until it is converted into nitro-cellulose. (This compound mixed with certain proportions of ether and alcohol will form collodion.) After thorough washing, to free it from the acids, the cellulose is dried, mixed with a certain quantity of camphor—and colouring-matter if required—and is passed through a roller mill. The material is now pressed into thin sheets by hydraulic pressure, and is afterwards broken up by toothed rollers and soaked for some hours in alcohol. Once more the compound is placed under heavy pressure, and after being submitted to a hot rolling process is finished. The resulting material is celluloid, in the form of ivory-like sheets half an inch thick.

At a temperature far below that of boiling water celluloid becomes soft and plastic, so that it can be moulded and will retain the finest impressions. It is soluble in ether and alcohol, and in this form it serves as a cement to join pieces of its own substance together. It is highly inflammable, and if heated to about 350° will violently explode on being struck with a hammer. When we remember that nitro-cellulose, which enters so largely into its composition, is identical with gun-cotton, we need feel no surprise at this explosive tendency. This property will naturally limit its employment, for people may think, with reason, that a substance so combustible might under certain conditions be liable to decomposition which might lead to spontaneous inflammation. But we understand that the tendency to inflame can be altogether stopped by admixture during manufacture with incombustible earthy bodies. If this be the case, celluloid is a material which must in time obtain a very extensive use; more especially because ivory—which it so greatly resembles—is becoming so scarce that its price prohibits its use for many purposes for which it was formerly employed.

A MYSTERIOUS DOG.

ABOUT seventy years ago a lady living in Manchester had occasion to visit Blackley, a village three miles distant. She started early on a summer afternoon, alone, and was somewhat frightened, soon after leaving the town, by the sudden appearance of a large and powerful dog, which seemed intent upon attracting her notice, but in a very friendly way. She endeavoured to escape it, but, her fears gradually subsiding, she walked quietly on, the dog gamboling and frisking about her. Reaching her friend's house, the dog, being shut out, waited for her on the door-step. One of the family going out, asked if the dog belonged to her. She said no, and told the story of its following her, upon which, with some laughter, the dog was invited in and made much of; but still attached itself exclusively to the lady it had followed, fawning upon her with the greatest apparent affection. Returning in the cool of the evening, the dog still accompanied her, evincing every symptom of delight and satisfaction. In the midst of a narrow lonely lane, shut in on each side by a thick thorn fence and lofty bushes, the friskings, barkings, and playful fondlings of the dog ceased, and he kept nearer her, a little in advance, sniffing now and then, but silent. Presently he evinced every sign of anger, uttering low growls, with hair erect, and eyes fiercely aglow. The lady became frightened, and tried in vain to quiet him with soothing words and by throwing cake to him. The dog heeded neither, but appeared to grow more and more excited, until at last, through a gap in the hedge, a ruffianly fellow sprang out with an open knife in his hand. The lady shrieked, and the dog, flying at the man, brought him to the ground. The fellow implored her to call off the dog, but she, being ignorant of its name, was unable to do so, and ran on as fast as she could, looking for assistance as she went. Presently the dog overtook her, barking and frisking as playfully as before; and when they reached the spot where she had first seen the animal, it at once left her, and she never saw it again.

THE MOUNTAINS AND CRATERS OF THE MOON.

THE physical appearance of the moon is far more satisfactorily discernible than that of any other celestial body. This is owing to two causes—namely, her nearness to the earth, and the fact that her surface is not shrouded in an atmosphere sufficiently dense to obliterate any of the details, which are invariably presented with a remarkably bold and distinct outline. We are thus enabled to chart her leading features with great accuracy; and there can be no doubt that, as an interesting telescopic object, no other orb in the firmament can vie with our satellite. The smallest instruments reveal at once the fact that a great mass of detail is visible

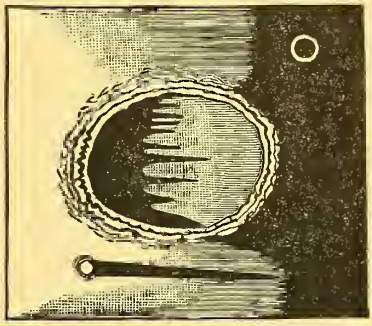


Fig. 1.—THE CRATER ARCHIMEDES AT SUNRISE.
Showing also effect of the horizontal sun-rays on two small annular mountains, known as *Archimedes* A and E.

on her disc, and that these consist mainly of craters and mountain-ranges, various in form and extent, and showing a very irregular distribution over the lunar surface.

Let us view the moon when in a crescent phase, for this is practically the most suitable time, though many people naturally think that the full moon will be the best spectacle. But it is obvious that, as the chief features of the moon's landscape consist of mountains and craters, these will be more favourably brought out during the time of first or last quarter, for the following reasons: The moon shines by light received from the sun, and the gradually-increasing breadth of the crescent really means that the sun is rising higher above those regions of our satellite presented to the earth. The concave border (called the terminator) is the line of demarcation between lunar night and morning. The illuminated border contains objects which have just come into sunlight, and the rays falling on them being very oblique, they are made to cast a variety of shadows, which show their real characters in bold relief (Fig. 1). But this effect is entirely obliterated at the epoch of full moon, because the sun is then shining vertically over our satellite, and there are no shadows to vary the scenery and indicate its nature, in fact, the moon's whole surface at such a time is bathed in a flood of lustre which entirely destroys the interesting contrast of light and shadow forming so conspicuous and interesting an effect at the crescent phase.

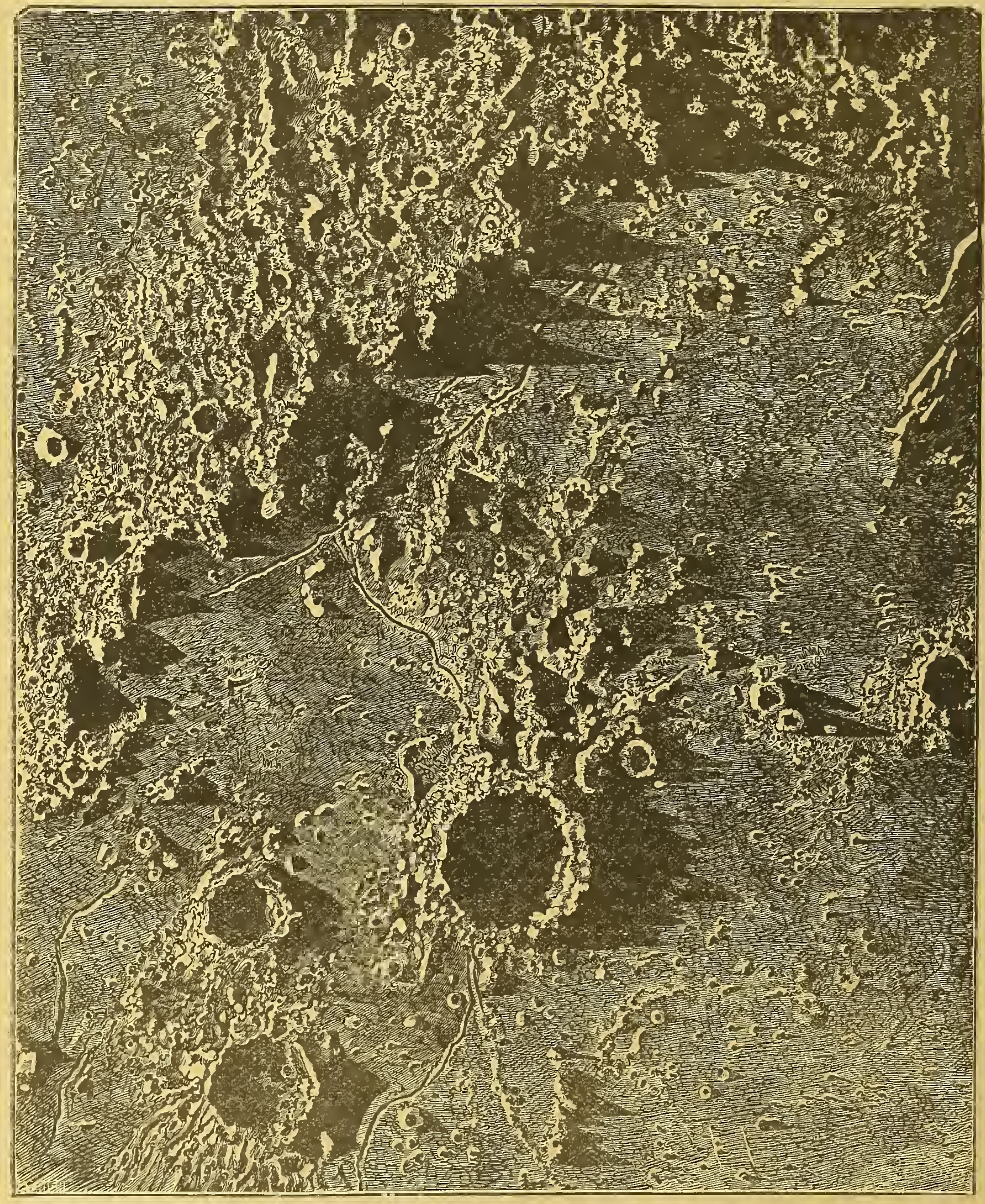


Fig. 2.—THE LUNAR APENNINES, WITH ANOTHER VIEW OF THE CRATER ARCHIMEDES. (*From Mr. De la Rue's Photograph.*)

The craters on the moon may be said to be infinite as far as our enumeration of them is concerned. There are many examples of large, deep craters, but these are rare relatively to the smaller ones; indeed, the numbers apparently increase with diminution in size. One of the most recent and comprehensive lunar maps * indicates the positions of no less than 32,856 of these crater-forms, and this number probably represents but a small proportion of the aggregate of such formations existing on the surface of the moon. It must also be pointed out that one and the same hemisphere is always turned towards the earth, so that we know nothing of the moon's hidden side more than inference teaches us from the visible side.

But this visible side reveals many wonderful structures, and an extent of detail which exhausts the power of the largest telescopes. At the first glance we see that the moon-scenery is vastly different from that of the earth. The surface of the moon is, in fact, a complicated mass of irregular formations. The craters are of immense extent in many cases. Amongst the most notable is Tycho, which appears to be an excellent sample of extinct lunar volcanoes. It is about 54 miles in diameter, and its depth 17,000 feet, or more than 3 miles. There is a central hill about one mile in height, and a massive wall surrounding it, outside of which are a vast number of small craters. Copernicus furnishes another fine specimen of the same class of objects. It is some 56 miles in diameter, and has a central hill with six peaks rising to 2,400 feet above the bottom of the crater, and the wall by which it is environed shows a very complicated arrangement of terraces and ravines, and reaches, in its more elevated portions, a height of 11,000 feet above the interior cavity. But one of the deepest of all the lunar craters is Theophilus, the opening in which, relatively to the surrounding wall or ring, falls to some 14,000 —18,000 feet. This crater is 64 miles in diameter, and has a central mountain about a mile high. The region of the moon's south pole is particularly rich in craters, much more so, indeed, than any other district of the visible surface. In the immediate vicinity of the pole there is Kircher, some 18,000 feet deep, and Cassatus, which exhibits a dome-shaped mountain upon its massive wall rising to about 22,300 feet; and Newton, a perfectly marvellous object, on account of its great depth and width, it being some 142 miles long, and its most elevated tower nearly 24,000 feet above the interior. These objects are altogether dissimilar to terrestrial formations, and must obviously originate a very grand and diversified extent of scenery upon the moon, especially at the times of sunrise and sunset.

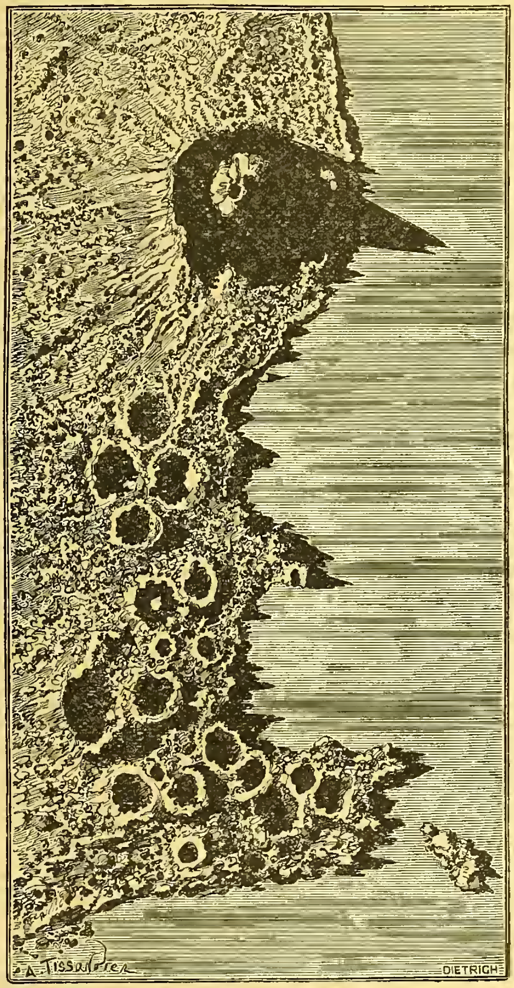


Fig. 3.—VESUVIUS, WITH THE ADJACENT NEIGHBOURHOOD.
(Photographed from a Relief-map by Messrs. Nasmyth & Carpenter.)

The lunar mountains are equally remarkable. The *Apennines* form an extensive mountain range of some 460 miles in length; and some of the various peaks are of enormous heights—*e.g.*: Huyghens 21,000 feet, Hadley 15,000, Bradley 13,600, Wolf 11,000, &c. The *Dörfel* mountains supply another instance of enormous elevation, the peaks of the three leading ones being about 25,000 or 26,000 feet. But the most striking of the lunar mountains are, like the craters, situated on the southern margin of the lunar landscape. Here the *Leibnitz* range attain enormous altitudes above the average level of the moon's surface, and are sometimes seen projected far beyond the regular curvature of the disc, thus destroying the circular contour, and giving it a notched or serrated aspect. Several of the peaks of these southern mountains measure 30,000 feet in altitude, and one has been estimated to reach 36,000 feet!

* Schmidt's map of 6-feet diameter, published by the German Government, is here referred to.

Though the lunar craters differ from our own, not only in their size, but in their vast internal depth, their floors being far below the surrounding surface, there is yet a strong general resemblance to terrestrial volcanic districts, which would be still more marked could these be seen from a great height. This will be perceived rrom Fig. 3, which is from a photograph, taken by Messrs. Nasmyth and Carpenter, of a map carefully modelled in relief of the country round Naples. Its strong general resemblance to the lunar photograph can be seen at a glance, though the terrestrial volcano is so small in comparison, that it would hardly be noticed on the surface of the moon.

In order that the lunar craters may be advantageously viewed, a telescope of moderate power will be essential, though with small, inexpensive instruments a very good idea of their appearance and structure may be obtained ; in fact, some of the more prominent features of the moon may be distinguished by the naked eye. But in a large telescope the spectacle is one of extreme magnificence. The craters in their almost infinite profusion and variety are well calculated to attract the observer to a long and attentive examination ; and the result of this examination must, we think, convince him that the surface of our satellite is probably that of an extinct or exhausted world. There is no sign of fertility of the soil—no objects which can originate the idea that animate creatures subsist there. True, an atmosphere of extreme rarity and little depth *may* be suspended closely over the surface and prove sufficient to sustain certain forms of life ; but it must be admitted, from the conditions prevailing, that such creatures, if existing, must be of extraordinary type. From the extremely precipitous character of the lunar crust, and the indications apparent everywhere of convulsions, resulting from a heated state of the surface at a remote period of its history, we conclude that probably the moon has long since passed that stage of its existence suitable to habitation.

BESSEMER STEEL.

PERHAPS no kind of factory can afford such mighty sounds and grand spectacular effects as one in which is carried on the modern Bessemer process of converting iron into steel. A visit to one of these places is, to any one unaccustomed to the sight, at once grand and impressive. The process affords a good instance of the manner in which results calculated and tried experimentally in the chemist's laboratory eventually result in causing revolutions in modes of manufacture which affect vast industries and great bodies of workers.

Before considering the Bessemer process in detail it will be necessary to describe briefly the method employed to reduce iron from its ores, to point to the differences which exist between cast and wrought iron, and to show how both differ from steel. Iron is so abundantly distributed, that most minerals contain it in some form or other. But our chief supply comes from the clay iron-stone found in South Wales and in Staffordshire. This ore represents an impure carbonate of iron mixed with various other bodies, such as lime, clay, manganese, etc. The clay iron-stone, after having been broken up and roasted, so as to expel water and other impurities, is placed in what is called a blast furnace. This consists of a conical erection several yards high, with an opening at the top through which it is fed with ore, together with the materials necessary for its reduction. The ore is placed in layers with limestone and coal, and after this is ignited a blast of hot air is blown through the furnace from below, thus raising the mass to a temperature which reduces the whole to a liquid state. The metal, by reason of its greater weight, sinks to the bottom, whilst the clay and lime form a liquid white-hot slag, which floats on the top as oil floats on water. Both are drawn off from time to time by apertures arranged for the purpose, fresh materials being constantly added through the aperture at the top of the furnace.

Cast iron formed in this way is not a pure metal, for it contains a considerable quantity of carbon ; five per cent., or even more. It also contains a small amount of calcium, aluminium, manganese, etc. After it is poured into the moulds prepared for it, and has become cold, its structure is found to be crystalline—that is to say, a fractured piece has the same kind of texture as a broken lump of sugar. Wrought or malleable iron, on the other hand, has more of a fibrous structure, like a piece of broken, stringy wood. To convert cast iron into malleable iron, it is heated in a reverberatory furnace, and submitted to an operation called "puddling." This consists in turning it about whilst in the furnace by means of long iron rods, so that each portion of the metal is successively exposed to the heated air. The contained carbon is thus brought to the surface and partly eliminated, for it combines with the air and forms carbonic oxide, which gas can be seen burning as a blue flame on the surface of the heated mass. As the process proceeds the metal becomes less and less fluid, until it forms a granular pasty mass. The heat is then raised, so that the particles may to some extent cohere. The material is now gathered by means of the iron rods into large masses, weighing about seventy pounds apiece, and these are withdrawn and submitted to the welding action of a steam hammer. After all this treatment the malleable iron still contains a small proportion of carbon—about one-half per cent.—but this is by no means detrimental to it ; it is considered, on the other hand, to be distinctly advantageous to it. But some of the other elements found in cast iron are very much the reverse. A small proportion of phosphorus, for instance, will render the metal brittle, and quite useless for many fields of labour in which wrought iron is employed.

To convert malleable iron into steel, *carbon is again added to it*, and the process commonly employed is called cementation. The purest iron which it is possible to procure is employed for this purpose. Bars of this best iron are placed in iron boxes filled with charcoal, and exposed to a red heat for many hours. Although the heat employed is far too low to fuse the metal, the carbon surrounding it in the form of charcoal slowly combines with it and alters its fibrous structure into one which is hard and close-grained. It is now called steel, and is distinguished from the wrought iron from which it was formed, not only by its texture, but by its wonderful tenacity. It also possesses the peculiarity that its nature can be modified by the process called tempering, by which it can be made hard, soft, tough, or elastic, according to the use for which it is ultimately destined. For special purposes—in making cutting instruments, for instance—the steel is melted, cast into ingots, and forged. In this condition it is known as cast steel.

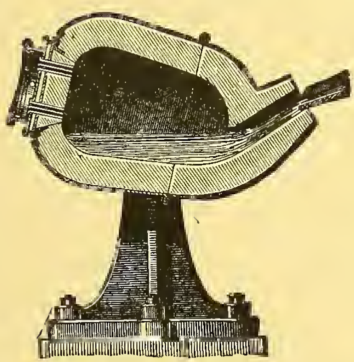


Fig. 1.—BESSEMER CONVERTER BEING FILLED.

It will now be seen that cast iron has a large proportion of carbon; wrought iron has but a small proportion of it; whilst steel takes an intermediate position between the two. It was natural to think that cast iron could be directly converted into steel by abstracting from it the requisite quantity of carbon, but this was found in practice till very lately to be next to impossible, for the right amount could not be easily controlled. More than this, there are impurities in cast iron which made the resulting steel, so far as it could be made, almost useless. The Bessemer process obviates these difficulties, and produces a good steel—much cheaper than others—which is extensively used for all manner of purposes.

The Bessemer process is conducted by means of a huge egg-shaped vessel called a "converter" (Fig. 1). It is made of wrought iron, and has a thick lining of infusible cement, made of fire-brick, sandstone, and other materials. It is supported, like a big gun, on trunnions, one of which is hollow, and communicates by means of an iron pipe with the bottom of the vessel. This pipe is to supply the vessel with air, which it does by means of an air-chamber separating the real bottom from the earthy lining. This lining is pierced with about fifty half-inch holes. The entire arrangement, by means of a toothed wheel, in connection with an hydraulic ram, on the opposite trunnion to that admitting the air-supply, can be made to assume a horizontal or vertical position, or can be turned completely upside down. It will be presently seen that these varied movements are necessary at different stages of the process.

A charge of eight or ten tons of molten cast iron is poured into the converter while it lies in the horizontal position. Its peculiar shape allows this to be done without any of the liquid metal touching the perforated bottom. The blast is now applied, and as the great mass begins by hydraulic action to move into the vertical position, the air under great pressure sweeps across the surface of the molten mass, and discharges a continuous rain of scintillating sparks. Slowly the converter assumes the upright position, the air all the time being forced through the perforated bottom with such force that no metal can possibly enter the holes through which it comes. With a mighty roar, and with a light as glaring as any electric lamp ever contrived, the fiery rain shoots in tangled masses out of the mouth of the monster, and falls in golden flakes many yards in front of it (Fig. 2). The most gorgeous fireworks ever exhibited pale before these wondrous and dazzling spangles of ejected metal. The oxygen of the air combines with the carbon of the iron, and passes off as gas. In a few minutes the spangles grow few and far between—the carbon and other impurities have been eliminated from the metal—the converter once more turns on its hinge to the horizontal position, the air-blast is shut off, and all is once more quiet.

But the operation of steel-making is not yet complete. The carbon and other matters have been driven off, and the air-blast has caused the metal to assume a far greater heat than it before possessed. It remains now to supply it with a definite amount of carbon. This is done by adding to it a charge of cast iron of a particular quality, containing a known amount of carbon, with ten per cent. of manganese. This metal is kept already melted in a cupola furnace, close to the mouth of the converter, and the two are readily connected with one another by a clay-lined channel, through which the molten metal pours into the converter. The steel is now ready to be cast into ingots of four or five hundredweight apiece, and in that form is ready for the manufacture of rails, plates, etc.

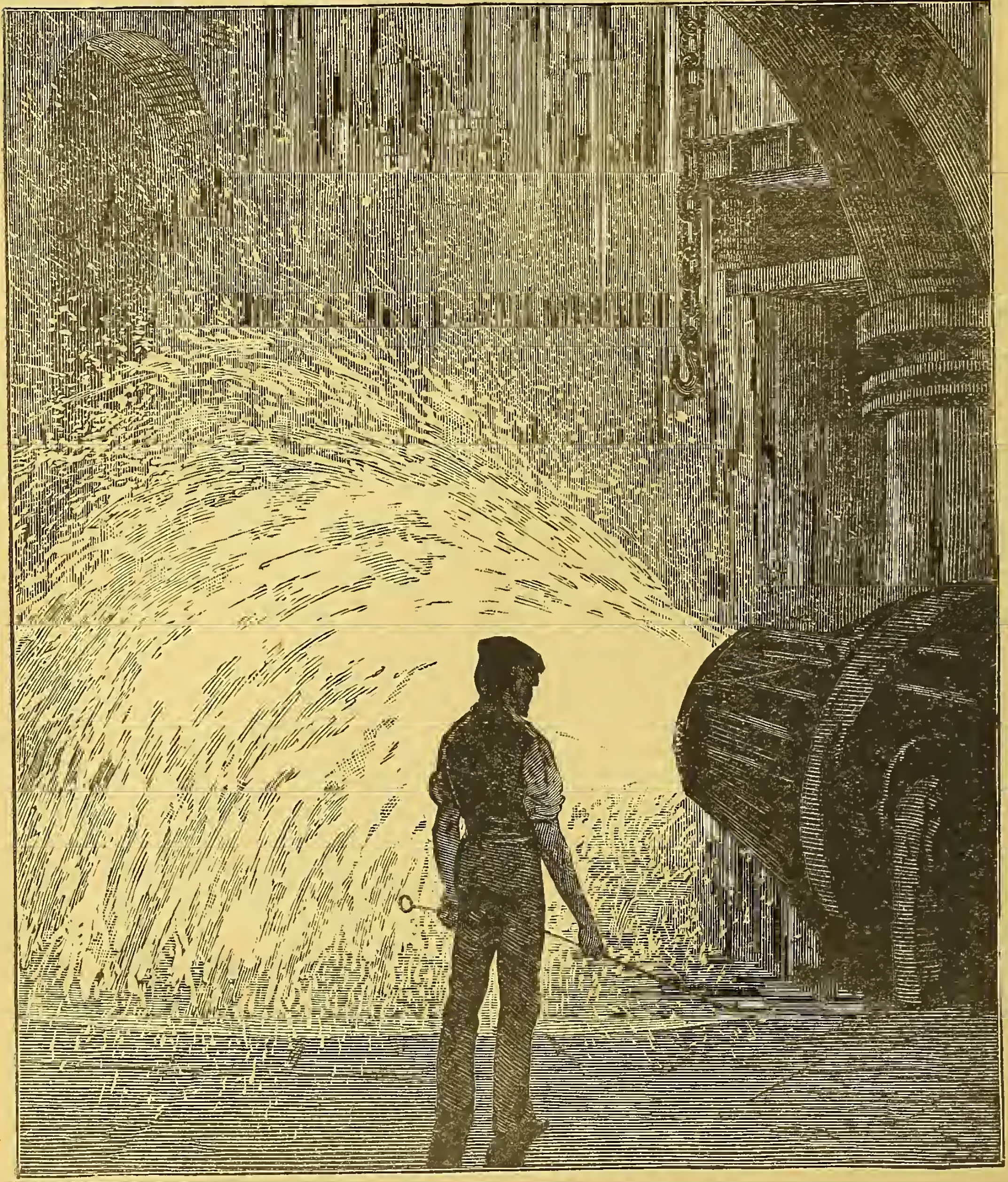


Fig. 2.—BESSEMER CONVERTER WITH THE BLAST TURNED ON.

In dealing with these enormous masses of metal man's unaided strength would avail him little. The operations are conducted as far as possible by the mighty aid of the hydraulic ram. We have already explained how the converter itself is upturned, and its movements regulated by hydraulic power, and the same aid is employed in various other ways. Thus, when the converter is emptied of its molten contents, a large vessel rises to meet its open mouth, and to receive the heavy charge. When full this vessel sinks to the level of a number of ingot-moulds arranged in a semicircle near it, and turns from one to the other, as it pours from a hole in its under surface a sufficient quantity into each one. In a short time an hydraulic crane swings over the pit, and by its aid each mould is seized, leaving its core, the red-hot ingot, behind it. This is also removed from the pit by hydraulic agency, and before long the converter is again roaring away with the burden of a fresh charge of iron.

It will now be understood that in the Bessemer process of manufacturing steel the metal is converted without the expenditure of any more fuel than that used to bring it to a fluid state in the blast furnace while it was yet iron. But the steel ingot, fresh from the mould, is not yet ready for the rolling-mills. Its exterior quickly solidifies, but the interior holds the heat, and remains fluid, so that even some time after it has left the mould, if it were possible to knock a hole in it, the fluid contents would run out, leaving a metallic shell. If, on the other hand, the ingot be kept until the interior has become solid, the exterior will have become too cold for working. For these reasons the custom had obtained of leaving the ingots alone for some time, and then re-heating them in a special furnace, so that the exterior might be brought to a sufficient heat to fit the metal for the action of the rolling-mills. But in June, 1882, Mr. John Gjers, of Middlesbrough, introduced, at the Darlington Iron and Steel Company's works, a method of working which does away with this re-heating, and the process has been found so successful, and economical of time, labour, and fuel, that it is coming into use in all the more important steel-works of the country.

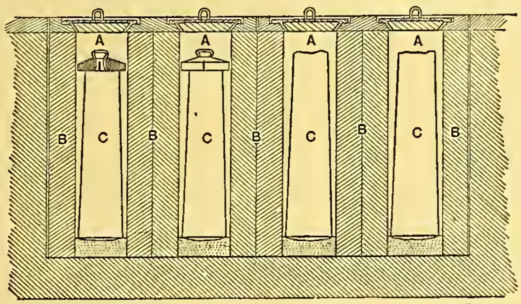


Fig. 3.—GJERS' SOAKING-PITS.

By this new system the ingots, C (Fig. 3), after being stripped from their moulds, are dropped into receptacles in the ground called "soaking-pits." These pits, each a little larger than the ingot itself, are carefully constructed of fire-brick, and other heat-holding materials, B B, with a bottom bed of non-conducting sand, and double covers, A A, of iron lined with fire-brick, one of which is placed on the ingot and the other on the mouth of the pit, with an air-space between. By this treatment the heat from the interior of the ingot gradually gets distributed throughout the metallic mass, until one part is as hot as another. After about thirty minutes' "soaking" in this pit—which all the time has been carefully covered to keep out the cold air—the ingot is raised, and looks very much hotter than when first deposited. It is now ready for the rolling-mills, the initial heat which it received as cast iron having been by careful management sufficient to carry it through all operations until it appears as a manufactured and saleable article. Even if the ingot be delayed in its passage to the soaking-pit, so as to lose much of its heat, the sides, being lined with bricks, have absorbed a quantity of heat which is given back to the comparatively cool ingot in question. One more advantage is gained by this soaking process. An ingot re-heated as of old, in the furnace, is bound to lose weight by oxidation. This loss is of course saved by the new method.

Such is, briefly, the Bessemer system of making steel, a process which, at the time of its first introduction in 1855, was welcomed in all parts of the world with the greatest enthusiasm. The impetus which it has given to the arts generally, in the application of steel to purposes from which its cost formerly excluded it, show that this enthusiasm was not unmerited nor misdirected.

RESTORED TO LIFE.

THOSE appearances which are popularly received as the sure and certain indications of death have been repeatedly shown to be common to certain rare forms of disease, and death's counterfeit has been so exactly like the real thing as to defy the most careful and experienced attempts to detect it. Some of the most wonderful of these instances are the following: others could be given.

A pamphlet on this subject, published many years since by Dr. M. B. Lessing, of Berlin, gives the following story as one for the truth of which he could vouch. The daughter of a wealthy Frenchman was married in Paris against her will. Some short time after, she died, as her friends supposed, and with all the usual forms and ceremonies was buried in the family tomb of her husband. The man she had loved bribed the sexton to permit him to have a last look at her body, the aspect of which convinced him that she was not dead. Restoratives were applied, by which she was recalled to life, and she fled secretly with her lover to England, whence some years after they ventured back to Paris, where she was recognised by her husband. Legal proceedings were instituted, to which the lady and her lover replied by asserting that the moral and lawful claim of a husband to the body of his wife ceased when it was entombed. A record of this extraordinary case, says Dr. Lessing, still exists in the "Parliamentary Register." The case was going in the husband's favour, when the lovers again took flight to England.

Dr. Macnish, in his work, "The Philosophy of Sleep," mentions the case of a young lady in the royal suite who had been long confined to her bed by a severe nervous disease, of which she ultimately appeared to die. Her lips became white, the face assumed every indication of death, and the body was icy cold. She was carried from the bed, placed in a coffin, and on the day of the funeral her friends assembled, and according to the practice of the locality, dirges were chanted before the house. Just as the undertakers were about to nail down the coffin-lid, some one noticed signs of perspiration, which rapidly increased, and were followed by convulsive movements of the feet and hands. She presently opened her eyes, and uttered a wail of agony and terror. She was in a few days restored to health, and stated that she seemed to be in a dream, and was perfectly conscious of what they were doing with her, but was perfectly unable either to speak or move. The horror of hearing the people outside singing her dirge, and the men beginning to nail down the coffin-lid, at last restored the power over her corporeal functions, and saved her from being buried alive.

Another instance belongs to the time of Queen Elizabeth, and is recorded in connection with the siege of Rouen by Ambrose Dudley, Earl of Warwick. Francis de St. Civile, leading his company into fight, received in his right cheek a musket-shot which, passing obliquely downward, was buried in his neck. He bled terribly, fell, was taken up for dead soon after, and committed to the grave. A faithful servant of his family, who had been in attendance upon him, being greatly concerned that his dear master's body did not rest in consecrated earth, procured the aid of several soldiers for its removal. They reached the spot in the quietude and gloom of the evening, and opened many graves with great dispatch and secrecy, being within reach of the guns of the besieged, but without finding the right one. As they were about to abandon their task in despair the faithful follower saw by the light of their torch something sparkling with great brilliancy near the ground. It was a diamond in a ring worn by a slain soldier so hastily interred that the arm and hand remained uncovered. Going near to examine he recognised it as his master's. The corpse was dug up, recognised, and carried away. The servant carried the body, and remarked with astonishment that it was still warm. Pausing to rest he looked tearfully into the still white face that had smiled into his own so often and so kindly, and as he did so, noticed, with a strange thrill, signs of faint breathing. They hurried on and reached a house; when, placed in a warm bed, De St. Civile very gradually recovered, the warmth increasing slowly during five days and nights. After other desperate adventures and narrow escapes he reached home. Monsieur de Thou, who knew the gentleman well, and received the story from his own lips, is the authority given for this astonishing narrative. It has been somewhat differently related by others. The above case resembles one mentioned by Plato, in which a warrior killed in battle was left amongst the dead for ten days, and came to life again on being carried away.

Pliny mentions two cases in which Lucius Aviola and Lucius Lamia came to life while on their funeral pyres, but were too much burnt to be saved.

The fate of the famous Abbé Provost, author of "Manon Lescant," is another case worth mentioning. While passing through the forest of Chantilly he was seized with an apoplectic fit. Some wood-cutters found his body on the following morning, and believing it to be dead gave it to the village surgeon, who, proceeding to open it, was horrified by discovering that the man was restored to life. He died in consequence of the injuries so inflicted.

Cullen mentions a hysterical woman, who, during six days, had every sign of death, and yet came back to life; and Licelus mentions the case of a nun he knew in Brescia, who, after a hysteric fit, remained without apparent life ten days and nights before signs of life returned.

In a local paper published in Lancashire is an account of a Mr. William Cowherd, of Cartmel, in that shire, who died, apparently, on the first Tuesday in June, 1778. All the common forms of ascertaining the reality of his death were used: a mirror applied to the mouth and nostrils, etc. His brother, in consequence of something he had read, was the only person who was not convinced of the man's death. He insisted upon both the room and the body being kept perfectly warm, and in about five hours he was rewarded by signs of returning animation. The man gradually recovered strength, and was once more restored to his friends and family.

In December, 1795, a supposed dead body was found in an open field, taken in an open cart to the workhouse, and placed beside another body really lifeless in the dead-house to await the coroner's visit. Some children peering in soon after noticed that the body last found appeared to be breathing. A surgeon was sent for, and animation restored within a few hours.

A rare pamphlet in the British Museum, called "A Wonder of Wonders," etc., describes the case of a woman named Anne Greene, whose death, as was supposed, followed her execution by hanging for the murder of her infant, a crime of which she was afterwards proved innocent. Her trial was conducted in a hurried and shamefully careless way, and she was hanged at Oxford on the 10th of January, 1650. At the ladder-foot she earnestly and solemnly protested her innocence ; and after she was thrust off, her cousin, at her request, hung with all his weight from her feet, and swung with her to ensure her quick and certain death, to hasten which one of the soldiers standing by struck her four or five violent blows upon the breast. She remained suspended for half an hour, and was then cut down. Her body, which had been stamped upon while in the coffin, was given up for dissection, and conveyed to the residence of an apothecary, where the doctors and students met to witness the operations, and hear the usual lecture upon that process. The body being stripped and placed upon a table, all present were startled to perceive faint signs of breathing. One, Dr. Petty, took her hand, and, placing his ear to the temple, declared that she was alive. She was bled, and placed in a warm bed with a woman who was induced to lie beside her to increase the heat. She was also rubbed with oils. After fully fourteen hours had elapsed she opened her eyes and spoke. The pamphlet says—"This poor creature, whom God, of His infinite mercy, hath evidently manifested love unto, is now indifferently well recovered, and can walk up and down her chamber ; but her neck is very sore and black withal ; her breast and stomach much bruised ; yet her pains dissuage daily ; and divers, both in city and country, frequent hourly to behold her. At her first recovery she seemed to be much aghast, her eyes being ready to start out of her head ; but by the great pains of honest and faithful Doctor Petty she is miraculously recovered, which moved many of her enemies to wrath and indignation, in so much that a great man amongst the rest moved to have her again carried to the place of execution, to be hung up by the neck, contrary to all law, reason, and justice." She was saved from this end by the soldiers of Fairfax and Cromwell, who were then in Oxford. The author of the pamphlet was, it is believed, Dr. Bathurst, afterwards President of Trinity College, Oxford.

In the year 1350 a malefactor, named Walter Wynkbourne, was hanged in Leicester, and after being suspended the usual time, his body was taken down for burial, and placed in a cart for conveyance to St. Sepulchre's churchyard. On the way it was discovered that he was alive, and a violent altercation arose between the priests, who gave the criminal sanctuary, and the man's prosecutors, who demanded his life, and would have had him hanged again. King Edward, who was then at the monastery, desired the man to be brought before him, and after examination, granted him his pardon, saying in Latin, "God gave thee life, and the king gives thee pardon."

Frank Thorpe Porter, a once well-known Dublin magistrate, and Sir Jonah Barrington, the one in his "Gleanings and Recollections," and the other in his "Personal Recollections," both mention as true the case of an Irishman named Lonergan, or Lanegan. He was a well-educated man, engaged as a tutor by Mr. Thomas O'Flaherty, of Castlefield, in the county of Kilkenny, with whose wife he had a criminal intrigue. On June 8, 1778, O'Flaherty died under suspicious circumstances, and warrants were issued for the arrest of both the wife and the tutor. She escaped ; he was taken, but remained untried until 1781, in consequence of certain legal quibbles. On the 12th of November he was pronounced guilty, and sentenced to be hanged and quartered, he having been arraigned for what was then called "petit treason." Lonergan persistently declared his innocence. He was hanged on a severely cold, inclement morning, cut down twenty minutes after, and placed face downward in the coffin, while the executioner, in formal compliance with the sentence of quartering, made two incisions in the back of the neck with his knife, one crossing the other. The body was then given to his friend McKenna, a priest, who superintended its apparent burial in a very deep grave, where a watch was kept for fear of body-snatchers. But the real body, restored to life, was secreted in the priest's house, where the father of Mr. Porter saw him. The man afterwards escaped to America, where, under the name of James Fennel, he became well known as an able schoolmaster.

A man named Reynolds, condemned to death for pulling down Lothbury turnpike, was executed at Tyburn in July, 1736. After hanging the usual time, he was cut down, and put into his coffin for burial as dead ; but as they were about to fasten down the lid, he thrust it aside and tried to rise. He would have been again suspended had not the spectators carried him off, after cruelly beating the executioner. He died from the injuries he had received very soon after.

On the 3rd of September, 1736, a man named Venham was executed with another, named Harding, at Bristol. Venham recovered in a similar way, and was restored to life by the timely aid of a surgeon, and he, like Reynolds, died soon after in great agony from the injuries received. The man who was executed with him was also restored to life, and was visited by a large number of people at the Bridewell. We can find no record of his after fate.

In September, 1811, a man and a boy employed in fixing a pump on Beeston-hill, near Leeds, on descending were overcome by foul air, and fell to the bottom. The boy was recovered first, and soon restored to animation, but the body of the man remained where it was three-quarters of an hour, and when brought to view life was supposed to be perfectly extinct. The body remained with every appearance of death upon it nearly an hour, and then suddenly began to display symptoms of returning animation.

Amongst other numerous well-authenticated instances of men pronounced dead by competent authorities being really alive is that of Isaac Rooke, who in July, 1794, was found in a close near Nottingham, to all appearance a corpse. He had been discharged from St. Bartholomew's Hospital in London some few days previously, and was on his way to Chesterfield, where he had a brother. The supposed body was placed on a board and conveyed to St. Peter's Church, where it was seen by a medical man, who instructed the clerk to give notice to the coroner. Just as those present were leaving the church one thought he saw the stomach of the body moving, and another examination showed that the poor fellow was really alive. He was removed to a neighbouring public-house, put into a warm bed, and proper methods were used for his perfect recovery, so that in a few days he was again on the road to his brother's house. He told the people at the public-house that he was subject to fits, in one of which he had once before been mistaken for a corpse, and actually placed in a coffin for burial, when he was seen to move, and so rescued from the grave. It was always his practice, after the second escape, to carry a written paper in his pocket directing those who might find and suppose him dead in what way to act.

In a work by M. de St. André, printed at Rouen in 1700, and entitled "Reflections on the Nature of Remedies; their Effects and Manner of Acting," we find the following case of extraordinary resuscitation :—A gentleman sixty years of age attacked by a fever had, as was believed, died. As there was something singular in the manner of his death, a post-mortem examination was asked for, and permission given for its performance, the preparations for the funeral going on in the meantime. It so happened that there was a dispute between two priests as to the right of each to conduct the religious ceremony of the funeral, and watch and pray beside the body for the departed soul. They met in the presence of the dead, began a dispute which ended in high words, and at last in blows. The father of M. André was summoned to stop this unseemly quarrel, and seeing that the face of the corpse had been uncovered, went to the bed to re-cover it. As he did so, he saw, or fancied he saw, some sign of life, but on examination, discovering no motion of respiration or pulsation, he concluded that he was mistaken. The impression remaining, he, however, again applied his touch to the head, and fancied he felt a very slight, scarcely perceptible, pulsation. He called for wine, rubbed the nose, lips, and temple with it, poured a little several times into the mouth, and had just concluded that his fancy had deceived him, when the eyes of the supposed corpse slowly opened. The "dead" man soon after completely recovered, and stated that every word of the quarrel between the two priests had been heard by him, and he remembered enough to convince them that he had done so.

Early in the commencement of the present century Sir Hugh Ackland was a well-known personage all through Devonshire. He had a favourite servant, whom he always called his "brandy footman," and to whom, on his death, he left a very handsome annuity. The origin of this servant's odd cognomen is thus explained :—Some years before, Sir Hugh was attacked by fever, of which it was believed he died. He was "laid out," and two of the footmen were appointed, with the nurse, to watch the body. They all drank freely of brandy; and one of the footmen said that his master so dearly loved brandy when he was alive, that he was determined to give him a drop now he was dead. This fellow accordingly filled a glass with the spirit, and poured it down the throat of the supposed corpse. The result was a curious noise in the throat, followed by a desperate convulsive movement of the neck and chest. This so terrified them that the men rushed headlong from the room, tumbling one over the other down the stairs, and the nurse set up such a terrific series of shrieks that she aroused the whole house. A young gentleman, who was the first to reach the room they had so precipitately abandoned, started back with astonishment to find the supposed corpse sitting upright, and struggling for life. He was removed to a warm bed, the doctor was sent for, and in a few weeks Sir Hugh was up and about, a healthy, vigorous man.

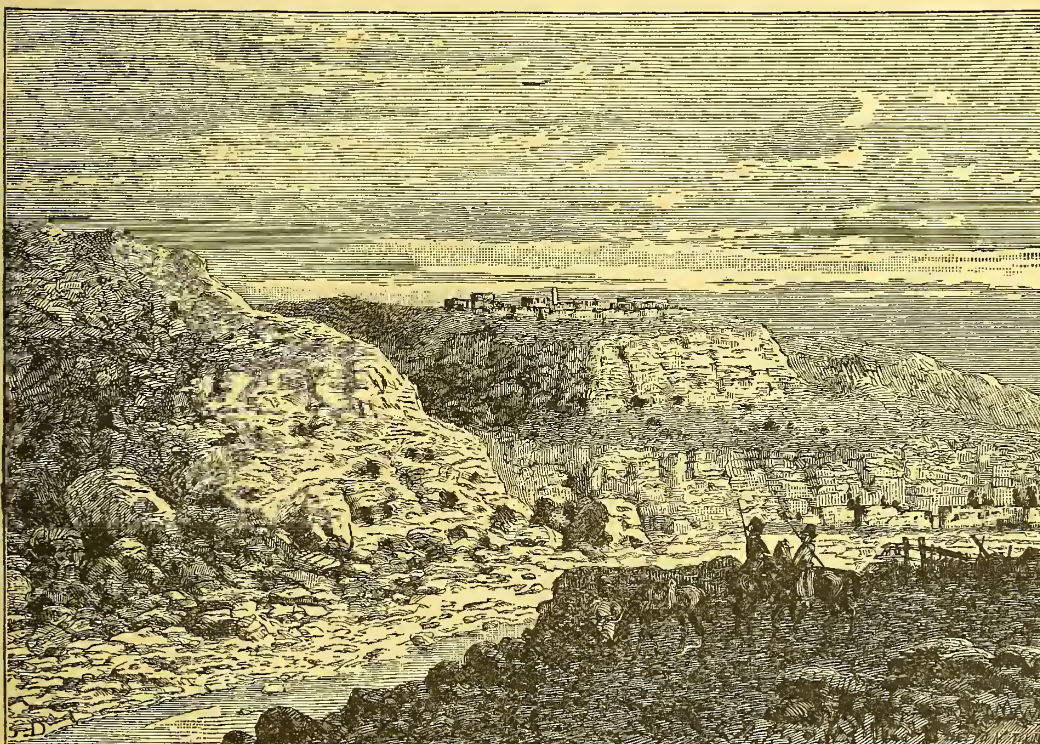
TURQUOISE MINES.

FROM times of remote antiquity all nations have prized those minerals which from their rarity or beautiful appearance could be described as precious stones. Among these the turquoise has ever held a foremost place, not only on account of its pure colour, which an old writer compares to "a clear sky, free from all clouds," but on account of certain talismanic properties which it has been supposed to possess. A Russian proverb tells us that the gift of this stone confers upon the recipient happiness and good fortune, and we are further informed that the turquoise will pale in its colour should the donor happen to be in any kind of trouble or danger. The Arabs have other superstitions connected with the turquoise, and will on this account be content to purchase those less perfect gems, which, because of being covered with white specks, fetch a comparatively low price in the market.

The true turquoise has a blue or greenish-blue colour, and is quite opaque, except in some instances where the edge of the gem seems to be translucent. It is capable of receiving a high polish, has a conchoidal fracture, and is of the following chemical composition :—

Phosphoric Acid ...	30·90
Alumina	44·50
Oxide of Copper ...	3·75
Oxide of Iron ...	1·80
Water	19·5

over and over in the roughest and most primitive way, in search of the coveted stone. One of these mines is represented by a bed of light earth, full of pits, having quite a deserted appearance. Another, known as the Black Mine, is crowded with dark brown stones, which have from time to time been thrown out of the excavations. These stones and the adjacent rocks are full of crevices, in which appear veins of blue matter, presumably stained by oxide of copper, from which the turquoise seems to be formed. Small nodules of the gem are here found attached to fragments of stone, and appearing like pimples of the finest blue. Part of the excavations are covered with a white efflorescence which the natives asserted to be alum, but this could not be determined by the traveller, because the rocks where it occurred were quite inaccessible. In the chief of these mines, from which the best stones were obtained, the rocks were more varied in their tints, and consisted of a kind of clay porphyry, the larger specimens of turquoise being found in a yellow ochreous clay.



TURQUOISE MINES AT KHORASSAN.

The finest examples of the gem are procured from certain mines at Khorassan, a place southeast of the Caspian Sea, and about forty miles west of the town of Nishapore, of which our illustration is a general view. These mines were visited by Mr. James Fraser, who has left an interesting account of them in a book published in 1826, "Travels and Adventures in the Persian Provinces."

From this account we gather that the gem is found in one particular hill, which has been excavated in different directions forming six distinct mines. But it must not be thought that these diggings are mines in the English acceptation of the word, for most of them appear to be simple pits in the earth, where the soil has been turned

The general mass of this hill in which these several excavations have been made consists of porphyritic rock, intermingled with beds of clay and conglomerate tinged with iron, the blue veins already spoken of being disseminated throughout in an irregular manner. As already pointed out, the mines are worked in a slovenly manner, the right of working being purchased from the Government by the inhabitants of the adjacent villages. Parties of these workers combine together and divide the proceeds of their labours, the stones being afterwards sold to travelling merchants, who visit the mines at stated periods, or sent to the town of Mushed for disposal. They are sold as single stones, or with part of the parent rock still attached to them, but in the latter case their value is of course much reduced. The stone-cutters live at Mushed, which in Mr. Fraser's time represented the chief seat of the trade. From this place the turquoises were sent to different countries, the finest finding their way, *viâ* Herat and Candahar, to India, whilst, by means of merchants trading with Russia, others reached Europe.

At the Exhibition of 1851, Major C. Macdonald exhibited some turquoises which he had, two years previously, collected in Arabia Petræa. His account of finding these stones is interesting. He says—"In the year 1849, during my travels in Arabia in search of antiquities, I was led to examine a very lofty range of mountains composed of iron-sandstone, many days' journey in the desert. Whilst descending a mountain of about 6,000 feet high, by a deep and precipitous gorge, which in the winter-time served to carry off the water, I found a bed of gravel, where I perceived a great many small blue objects mixed with the other stones ; on collecting them I found they were turquoises of the finest colour and quality. On continuing my researches through the entire range of mountains, I discovered many valuable deposits of the same stones, some quite pure like pebbles, others in the matrix. Sometimes they are found in nodules varying in size from a pin's head to a hazel-nut, and when in this formation they are usually of the finest quality and colour. The action of the weather gradually loosens them from the rock, and they are rolled into the ravines. In the winter season they become mixed up by the torrents with the beds of gravel in which they are found. Another formation is where they appear in veins, and sometimes of such a size as to be of immense value. They also occur in a soft yellow sandstone of a surpassing brilliancy of colour. Another very common form is where they are combined with innumerable small coloured quartz crystals, and which has the appearance of a mass of sand, small pebbles, and turquoise, all firmly cemented together. This formation is one of the most peculiar in the whole collection.

More recently the turquoise has been found in Mexico, at a place about twenty-two miles south-west of Santa Fé. The rocks where they occur are of a white colour like China clay, and exhibit evidence of decomposition, due, it is believed, to the escape of heated air and other gases. The turquoise is here also found in veins, and small nuggets, large specimens being so rare that often many tons of rock are removed without yielding a single stone.

The value of the turquoise varies so greatly that it is almost impossible to give a fair idea of the price any stone will fetch. A perfect specimen of the size of a shilling is said to have been sold some years back for £400. Another, nearly two inches long, in the possession of a jeweller at Moscow, was valued at double that sum ; but its price was probably enhanced from having been engraved with a verse from the Koran, and having a history attached to it.

The true turquoise must not be confounded with what is known as the bone, or fossil turquoise. In Siberia, and also some parts of France, this stone is found. It is supposed to be really the tooth of some fossil mammalia, which has become coloured by long contact with metallic oxides. It is easily distinguished from the true stone by chemical tests. The turquoise can be readily imitated, but the factitious gem cannot be made to approach the genuine stone in hardness.

PHILOSOPHICAL ECCENTRICITIES.

THE names under which scientific societies arose in Sicily in the latter half of the sixteenth century, when experimental philosophy was in its infancy, are very curious. One was called "The Drunken," another "The Rekindled," a third "The Saddened," a fourth "Sympathetic," a fifth "The Intrepid," and others "The Della Crusca," "The Inflammable," "The Pensive," "The Humorous," "The Sleepy," "The Unripened," &c. Of one "The Lyncean," Galileo was a member. The Academy Della Crusca survived its fellows some hundreds of years. In its hall of meeting in the Palazzo Ricardi the chairs for the members had their backs shaped like winnowing shovels, and the seats were made to resemble sacks. On election each member assumed some name connected with the miller's trade, and was awarded with all due business-like form and stately ceremony a large estate in Arcadia.

As illustrative of the investigations pursued before these societies, one experiment may be mentioned which for long after was accepted as conclusive, although now pronounced fallacious. A sphere of gold was filled with water, through which it was forced by pressure, and this was held to be sufficient proof that water was perfectly incompressible. We owe, however, many useful hints and discoveries to these early investigators of nature's works. Our own Royal Society gravely discussed the most absurd pretensions and supposed facts, such as were the questions "Do diamonds and other precious stones grow again after three or four years in the same places where they have been digged out?" "What river is that in Java-Major that turns wood into stone?" "Whether, in the island of Sumbero, which lyeth northward of Sumatra about eight degrees, northern latitude, there be found such a vegetable as Mr. James Lancaster relates to have seen, which grows up to a tree, shrinks down, when one offers to pluck it up, into the ground, and would quite shrink unless held very hard? And, whether the same, being forcibly plucked up, hath a worm for its root, diminishing more and more, according as the trees grow in greatness: and as soon as the worm is wholly turned into the tree, rooting in the ground and so growing great? And whether the same, plucked up young, turns by the time it is dry into a hard stone, much like to white coral?" One of the papers actually published by this society and communicated by its president, Sir Robert Moray, describes as *seen* by the writer in the western Islands of Scotland shells adhering to trees, each containing a perfectly-shaped bird of a small size.

In the minute-book of the old Philosophical Society of Oxford mention is made of a handkerchief brought from China made from the wool of the salamander (*Linum asbesti*), which was placed before the members in a fierce charcoal fire without being burnt, and even when oiled and replaced in the fire remaining uninjured, the oil being burnt away and the handkerchief unchanged save in the loss of weight to the extent of two drachms and five grains, and in its becoming while hot, brittle. This was no doubt asbestos.

In the Ashmolean Museum is figured the head of a dodo, a dragon's head, and two feathers from the tail of a phœnix, together with the claw of a rocke, a bird "able to trusse an elephant," an entire dragon two inches long, a bird of Paradise "without legges," &c.

One of the philosophers of the seventeenth century, Sir Kenelm Digby, a member of the Royal Society, proceeded to apply science to the preservation of beauty in the person of his wife, by feeding her upon capons fattened on a diet of vipers. He believed he had discovered the unknown power which united men and things almost in the way described in Youths' Christmas story of the learned professor who traced the same sympathy, which he illustrated in the case of lambs and green peas, and that of geese, sage and onions. Hardly less strange was Bishop Wilkins's grand project displayed in his philosophical work entitled "The Discovery of a New Worlde; or, a Discourse tending to prove that it is probable there may be another habitable World in the Moone, with a discourse concerning the probability of a Passage thither."

THE TALLEST TREES IN THE WORLD.

IT is usually considered that this epithet belongs, *par excellence*, to the famous "Big Trees" in California, variously known by the names of Wellingtonia or Sequoia. These are, however, far surpassed in height, and probably also in the total amount of timber in a single tree, by the real giants of the vegetable kingdom, the noble Gum-trees of the genus *Eucalyptus*, which grow in the Victorian State Forest, on the slopes of the mountains dividing Gipps Land from the rest of the colony of Victoria, and also in the mountain-ranges north of Cape Otway, the first land which is usually "made" by any vessel bound from England for Melbourne direct. As will presently be shown, there are only four of the Californian trees known to be above 300 feet high, the tallest being 325 feet, and only about sixty have been measured that exceed 200 feet in height. In the large tracts near the sources of the Watts river, however, (a northern branch of the Yarra-yarra, at the mouth of which Melbourne is built) all the trees average from 250 to 300 feet in height, mostly straight as an arrow, and with very few branches. Many fallen trees measure 350 feet in length, and one huge specimen was discovered lately which was found, by actual measurement with a tape, to be 435 feet long from its roots to where the trunk had been broken off by the fall; and at that point it was 3 feet in diameter, so that the entire tree could not have been less than 500 feet in total height. It was 18 feet in diameter at 5 feet from the ground, and was a Eucalyptus of either of the species *E. obliqua* or *E. amygdalina*.

It should be noted that these gigantic trees do not, like their Californian prototypes, grow in small and isolated groves, towering above smaller specimens of the same, or of closely-allied kinds, but that, both in the Dandenong and the Otway ranges, nearly every tree in the forest, over a large area, is on this enormous scale. Although they are not 40 miles distant from Melbourne, and a coach runs from thence through the forest three times a week, the existence of these vegetable giants is scarcely known to Melbourne people; and it was only after many fruitless inquiries among his Melbourne friends, and a reference to Baron Von Müller, F.R.S., the Government botanist, that the present writer was put in the way of seeing them. A ready means of reaching them is therefore here given. A Melbourne coach runs up the valley of the Yarra, through the Victorian vineyards, where most excellent red and white wines are made, to Healesville, about thirty miles from Melbourne. From there, a splendid road, engineered on the side of the forest-covered hills, leads to Fernshaw, seven miles distant, a small township beautifully situated in a glen at the foot of the Black Spur, in the valley of Watts river. In December, 1880, the hotel was, and had been for the previous sixteen years, kept by Mr. Jefferson, the members of whose family are capital guides in the forest, and point out all the finest trees. wonderful trees ; but no picture can convey a correct impression of their enormous height.

These Eucalypti are in fact more remarkable for their height, and for their remarkably straight trunks, branchless for at least half their height, than

Fig. 1.—AUSTRALIAN GUM-TREE (*Eucalyptus*). (*From a Photograph.*)

Continuing along the same road for three or four miles more, the top of the Black Spur is reached, an ascent of 1,200 feet having been made, and in the course of this walk several of the tallest trees are seen quite near to the road. Some of them are occasionally felled, and the manner of doing this is shown in the annexed engraving, from a photograph. The illustration gives some idea of the scale of the lower portions of the trunks of these for their girth, in which respect they do not come up to the largest Wellingtonias. The largest one, however, known as "Big Ben," cannot be quite spanned by the outstretched arms of eleven men. One very striking feature in the scene is the exceeding size and luxuriance of the tree-ferns which form the undergrowth in this forest of giants. These are themselves about 50 feet high, occasionally even taller, and it is really not until a comparison is made between the height of a man and of the tree-ferns, and of these again with the Eucalypti, that the observer can form anything like a correct idea of the scale of the scene presented to his astonished gaze. Looking at a photograph of the whole scene, the European naturally refers all the graceful ferns, similar in general appearance to those he is familiar with, to the standard of his own brackens or male ferns, and cannot realise that some of them would stretch over the roof of a lofty church. Miss Marianne North's drawings made near Fernshaw, and with exceedingly great liberality presented, with several hundred other floral landscapes, to the nation, and exhibited

Fig. 2.—BIG TREE OF CALIFORNIA (*Sequoia gigantea*). (*From a Photograph.*)

at Kew Gardens, fail to convey a correct notion of the size of these trees, although the general characteristics of the vegetation of the district are most faithfully rendered.

It may be well now to compare with these Eucalypti, the Wellingtonias, or, more properly, the Sequoias, of California, the only others which can compare with them. They were first discovered in 1852, and were carefully described by botanists two years later, when seeds of them found their way to Europe; they are now known

Palace at Sydenham, where it was unfortunately burnt. The following table gives the measurements of some of the largest :—

Name.	*Height.*	*Circumference 6 ft. above ground.*
Keystone State ...	... 325 feet ...	... 45 feet
General Jackson ...	.. 319 ,, ...	... 40 ,,
Mother of the Forest ...	... 315 ,, ...	... 61 ,,
Daniel Webster ...	... 307 ,, ...	... 47 ,,
P. Starr King ...	... 283 ,, ...	... 52 ,,
Jas. King of William ...	... 274 ,, ...	... 51 ,,
Mother and Son ...	... 261 ,, ...	... 51 ,,
Geo. Washington ...	... 256 ,, ...	... 51 ,,

Fig. 3.—IMPROMPTU BALL ON THE STUMP OF A *Sequoia*.

as *Sequoia gigantea*, and are closely allied to the redwood, or *Sequoia sempervirens*, both being *Coniferæ*. The latter is strictly a coast-range or seaboard tree, while its twin brother, the "Big Tree" is exclusively limited to the Sierra, and only occurs between 5,000 and 7,000 feet above the sea, and between 36° and 37° 15′ north latitude. It has never been found out of California, and probably never will be. As stated above, the "Big Tree," occurs in groves or patches, of which there are eight, more or less known, but only two are usually visited by travellers. That known as the Calaveras grove, the one first of all discovered, is one of these. It occupies a belt 3,200 feet long by 700 feet broad, and contains about ninety large trees, from one of which the bark was stripped for exhibition in the Crystal

Most of the trees in this grove, and some in a more recently discovered grove three or four miles to the south of it, bear tablets of wood or of marble inscribed with names. Some of these are fanciful, but others are memorable; such as Lafayette, Sir John Franklin, John Bright, William H. Seward, Gen. Sherman, &c. Four, of white marble, bearing the names of Humboldt, Agassiz, Charles Sumner, and Argyll, were put up in 1870 by two Boston gentlemen, the last-named tablet being in grateful remembrance of the Duke of Argyll's advocacy of the cause of Liberty and Law during the American Civil War.

The felling of one of the trees in this grove occupied five men, with pump augers, twenty-two days. At 40 feet from the ground it was again cut through, and 1,255 rings of growth were counted; it is not known at present, however, whether the growth-periods so marked were annual or not.

The second grove, known by the name of Mariposa, is sixteen miles south of the celebrated Yosemité valley, and contains, in an area of 3,700 feet by 2,300 feet, 125 trees above 40 feet in circumference. None of them are as high as, though they are larger in girth than, those in the Calaveras grove, as the following few measurements will show. The tallest tree is 272 feet high, but there are two above 90 feet in circumference at the ground, seven between 80 and 90 feet, seven between 70 and 80 feet, and four between 60 and 70 feet. Through one of the dead trunks a road has been cut along which a carriage and pair can readily be driven; and a ring of bark stripped from another formed all but the roof of a good-sized shanty, and was used as such. Perhaps the best idea of the size of these trees will, however, be gathered from our third illustration, copied from a New York engraving, which represents an *impromptu* ball got up by a party of American excursionists on the levelled stump of one of these forest giants, which was found on measurement to be about twelve yards in diameter.

A great number of these trees have been seriously damaged by fire, both by the Indians and by the white settlers. In one case, a tree of which a large portion of the bark had been burnt away still measured 103 feet in circumference near the ground, and into the trunk of a prostrate one which had been burnt hollow three horsemen could ride abreast for a distance of 30 feet, its height and width being 11 feet.

TORPEDO WARFARE.

AMONG engines of war which have lately attracted attention, and which have formed the subject of repeated experiments, are those explosive mines for use at sea called "torpedoes." Their origin is by no means modern, for floating structures containing gunpowder were used by the English more than 250 years back, at the siege of Rochelle. At the Crimea, the Russians, for the protection of their harbours, used iron vessels sunk below water, and filled with powder. These were so primed with a chemical mixture that the blow from a passing vessel would explode the charge. In the American civil war, torpedoes—as they were then first named—took a far more important part, for it is on record that about forty Federal ships were blown up and sunk by their aid.

The rough contrivances adopted by the Russians in the Crimea just mentioned were called "infernal machines;" and although, in the light of recent improvements they may be looked upon as mere toys, they represent the type of one class of torpedo—*i.e.*, that which is in a fixed position, anchored to the ground, and intended only for purposes of defence. The gunpowder with which they were charged has now given place to the far more powerful gun-cotton, dynamite, and other modern explosives of the same death-dealing family; and whereas the "infernal machine" was hazardous to friends and foes alike—being quite uncontrollable—the modern stationary torpedo can be so controlled that a friendly ship can pass unscathed above it, while an enemy's vessel can by it be as easily sunk to the bottom.

In the war between Austria and Italy, large torpedoes were used as a protection to the waterways of Venice; and although they were, like the Russian "infernal machines," sunk under water, they were under perfect control from the shore by means of electric wires. These torpedoes consisted of huge barrels, each containing about 400 lb. of gun-cotton. Chained to a framework resting on the ground, they floated a few feet below the surface of the water. In order that those on land might know when an enemy's ship passed over one of these submarine mines, a most ingenious plan was adopted. Most of our readers will know what a camera obscura is; there is one at the Crystal Palace, for instance. Entering a dark room, one sees in the centre a white table, upon which, by means of a mirror and lens fixed in an aperture above the ceiling—usually of a dome shape—a picture of all that is passing outside is visible. We see crowds of people, and can even recognise our own friends, if any happen to be within reach of the lens. Now, it was this contrivance that was cleverly applied by the Austrian engineers to the purpose of torpedo warfare. When the torpedoes were first laid in their respective places, the operation was carefully watched on the white table of such a camera obscura. As each mine was sunk in its bed, its place was marked on the table, so that afterwards, if an enemy's ship were to sail over one of these marked spots, the touch of a trigger, making electric connection with a battery under control of the observer, would explode the torpedo and sink the vessel. As events turned out, it did not become necessary during the war referred to to test the efficiency of this system.

Later on, another very clever way of tracing a ship's course over sunken mines was elaborated. This plan is available for a larger extent of surface than that which could be correctly controlled by the former method. Let us suppose that a large bay is the piece of water in which certain torpedoes are sunk as a protection, perhaps two miles away from land. On the shores of the bay two observing stations are established, two miles apart from one another. These two stations are connected by an electric cable. Wires from each sunken torpedo are also carried to the shore stations, so that when the circuit is closed, any one of the torpedoes can be exploded at will. At each station there is a telescope, which is turned horizontally upon a kind of dial, and the marks upon this dial show when the instrument is pointing towards a torpedo spot. If an enemy's ship come within the field of view of this telescope, the operator depresses a key, to make electrical contact with the exploding battery. But no explosion will take place unless the operator at the other station has gone through a similar experience. In other words, the approaching ship must be seen by both operators through their telescopes, and each must depress the electrical key under his control before an explosion can take place. It can be easily understood how a ship, to one operator, might appear to be in the right place, while the other operator, having a side view, as it were, would clearly notice that the vessel was half a mile away from danger.

The remarkable change which has taken place in the naval armament of this and other countries, in the substitution of ironclad vessels for "wooden walls," has stimulated inventors to contrive methods of destroying those massive men-of-war against which ordinary missiles are powerless. The submarine torpedo is, of course, effective enough for this purpose, but such engines can only be used near land; and the modern ironclad is so heavily armed that it can throw its huge projectiles from an immense distance while it is out of harm's way itself. These considerations led to the introduction of the torpedo-launch, a large number of which vessels are now attached to our own navy. France, Russia, Italy, and even Norway and Sweden, are all furnished with similar vessels. In these launches the torpedo no longer appears as a weapon of defence, but as an engine of offence of the most terrible character. Our torpedo-boats are built of thin steel, and furnished with such powerful engines that many of them attain a speed of twenty-five miles per hour. They may be divided into two groups: first-class and second-class. The second-class boats are small, and intended to be carried by ironclads, to be dropped into the water when required. The first-class launches, on the other hand, are large enough to take care of themselves, and to undertake more aggressive duties. The part played by one of these torpedo-launches is likely to be a very important one in future warfare. Insignificant-looking in itself, it may be compared to a little snake whose poisonous fangs are capable of killing a creature two or three hundred times its own size. Launched under the cover of night, it can speed along the water almost silently, until it reaches an enemy's ship. A spar, having at its end a charge of dynamite—a spar torpedo, as it is called—is thrust out from the little vessel, until it touches the side of the enemy's ship, far under water, in a vulnerable place. A terrific explosion follows; the little vessel quickly glides away, and the wounded ship almost as quickly fills with water, and sinks.

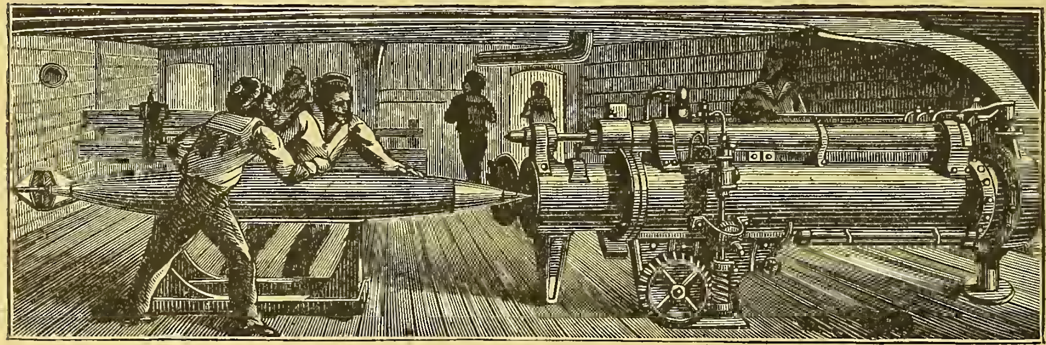


Fig. 1.—WHITEHEAD TORPEDO BETWEEN DECKS OF H.M.S. "INFLEXIBLE."

In order to be protected against these insidious enemies, our ironclads are furnished with many modes of defence. A powerful electric light, for instance, is arranged so that it can sweep the seas with its rays for many miles all round. By this means the smallest boat is quickly discerned, and precautions against its approach are speedily organised. The hull of the ship can be protected with a kind of crinoline of rope-work; but this defensive armour is of a cumbrous and ineffectual nature. The powerful machine guns, placed in different parts of the ship, can keep up a continual hail of bullets of such a size as to easily pierce the thin shell which composes the hull of a torpedo-boat. It also becomes necessary for the ironclads themselves to carry torpedoes; and the annexed cut shows the arrangements provided on board the *Inflexible* to meet this want.

This sketch brings us to a more forward point in the history of torpedoes, in the consideration of

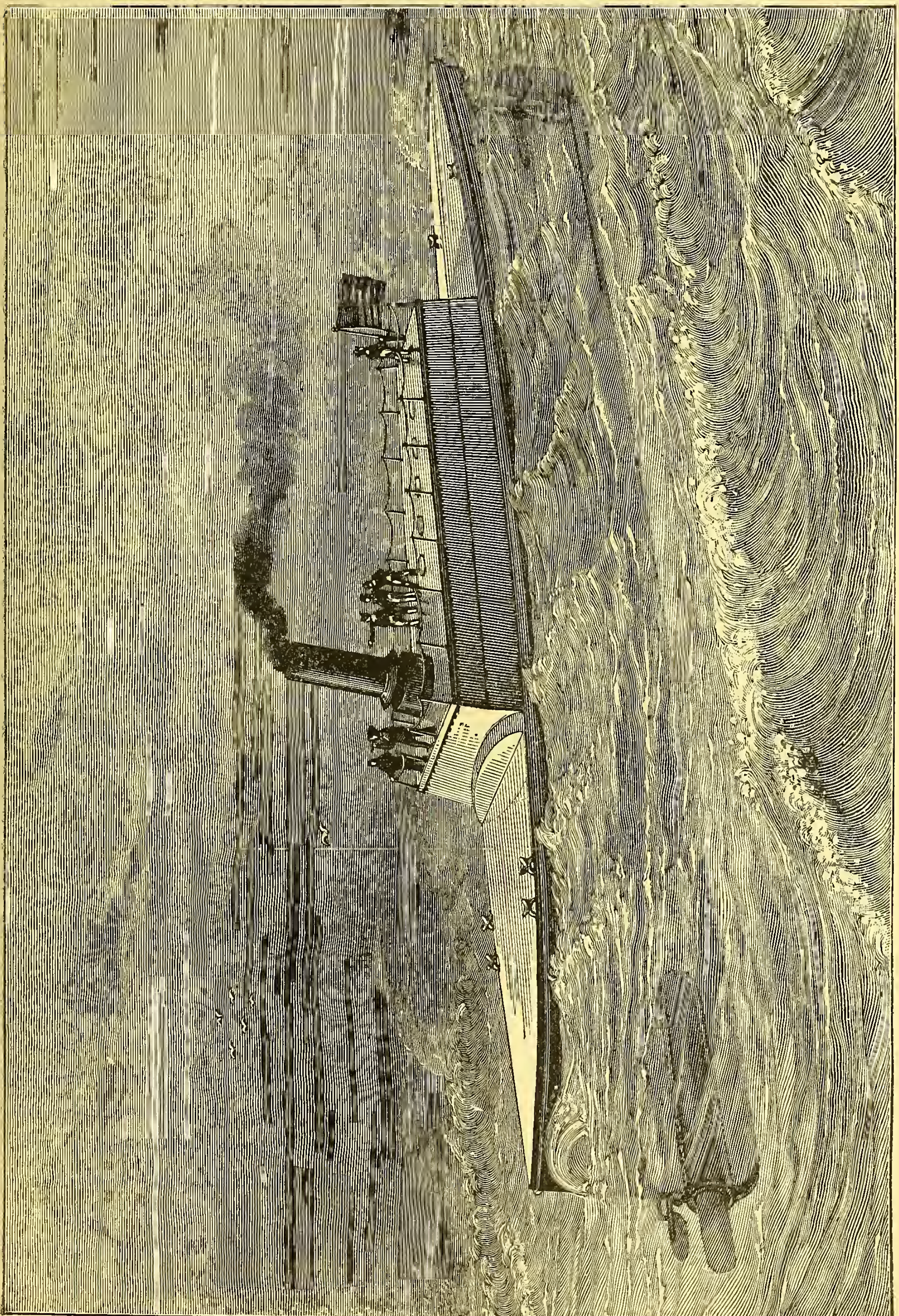


Fig. 2.—THE " DESTROYER " TORPEDO-VESSEL OF CAPTAIN ERICSSON.

those which are not only locomotive, but contain within themselves their own motive power. Still referring to the figure, we can learn something about the nature of these improved engines of destruction. Under the guidance of two sailors, a cigar-shaped structure, having a screw propeller at one end, is being wheeled on a truck, preparatory to being inserted in a hydraulic tube. The other end of this tube is, by means of a closed port, in communication with the sea outside. The cigar-shaped body is a Whitehead's torpedo, and by the initial thrust given to it by the hydraulic tube, as well as by its screw propeller, worked by compressed air, it is urged through the water at great speed, and will travel 500 yards at least before its motive power is exhausted. These torpedoes now form part of the armament of many other nations besides our own. The objections to their use are the uncertainty of aiming them so that they will travel to their assigned destination, their liability to be turned far out of the right track by strong tides or currents, and the loss of all control over them when once they have commenced their journey through the water. We shall presently see that these difficulties have been obviated in a remarkable way by a more recent invention.

In the meantime, we will glance at a formidable torpedo-vessel invented by Captain Ericsson, the Swedish engineer, which was built a few years ago in America, and very appropriately named the *Destroyer*. Our picture of it will show that its hull is almost completely submerged, a small superstructure appearing alone above the surface of the water. Its propeller and rudder are so far beneath the surface as to be quite safe from shot and shell, and its engines and boiler are in like manner fully protected. The vessel is 130 feet long, eleven feet deep, with an extreme breadth of twelve feet. It will be thus seen that its shape is extremely narrow for its length, so that while it presents, *end on*, a very small point to aim at, it can travel through the water at a tremendous speed. It carries a special form of locomotive torpedo, somewhat like the Whitehead; and the sketch will sufficiently indicate how the weapon is launched from a tube below the prow of the vessel. The total cost of the *Destroyer* is £20,000—a small sum when we compare it with the value of the ships which it has been designed to annihilate. There is no kind of doubt that under favourable conditions it would be capable of sinking any iron-clad afloat.

Improvements in weapons of offence and defence come so quickly one upon the other, that any particular invention has hardly been experimented upon and adopted before it is pronounced obsolete by the introduction of some far more effective appliance. So it has been with our armour-plates, our big guns, and our small arms, and so it must necessarily be with the torpedoes which we have described. For particular uses, and in smooth seas, where there is little current to divert its course, the Whitehead is likely to hold its own for some time to come, but for harbour defence, where contrary currents very often abound, a more certain implement must be employed. Such a one is that contrived by Colonel Lay, which at present stands by itself as a locomotive torpedo, and which can be steered from a vessel or from the shore with such unerring certainty, that it can thread its way between obstacles until it reaches the object of its attack.

The Lay torpedo is a cigar-shaped steel structure, measuring twenty-six feet in length by two feet in breadth at the widest part. It is divided into three compartments: the bow section containing the explosive charge—90 lb. to 150 lb. of dynamite; the middle section the motive power—carbonic acid gas; and the after section the steering apparatus. The weight of the entire machine is a ton and a half. It is guided in its course by means of electricity, furnished by a battery at the starting-point, and the means of communication are provided by light wire, which is paid out by the torpedo itself as it proceeds through the water.

By direction of the Turkish Government, this torpedo was lately submitted to a trial of the most rigorous nature. A spot on the Bosphorus was chosen where rapid and contrary currents abound to an extent which would puzzle a skilful oarsman. Two boats were moored close together about one mile from the shore, and when the torpedo was let loose it was steered from the shore so accurately that it ran between them, turned round, and came back to the starting-point. It will be seen from this experiment that the torpedo can no longer be regarded as a thing which may hit or miss an approaching vessel, but it can be trained, like some living thing, to go out to meet its enemy. The Lay torpedo represents the most perfect and most deadly engine of its class; but while we admire its ingenuity, we cannot help regretting that so much skill should be employed in compassing the destruction of human lives.

THE GROWTH OF CORAL.—After a cruise of a few months in the South Pacific in 1881, a French man-of-war was recently found to have specimens of living coral growing upon her hull. This interesting discovery has thrown some light on the question of the rapidity of growth of corals. The evidence tends to show that the vessel on passing a reef of the Gambier Islands, against which it rubbed, had picked up a young fungia, which adhered to the sheathing of the ship, and grew to the size and weight it had when observed—a diameter of 9 inches, and a weight of 2½ pounds—in nine weeks.

THE WOODEN SENTINEL.

It is often a matter of wonder when we find what serious importance has been attached to mere forms and ceremonies, even when separated from everything that gives them meaning. Thus, in 1806, when the French were in Naples, and the Bourbon court had fled into Sicily, a superannuated princess of that royal house, of illegitimate birth, half-sister to the old King Ferdinand, was left behind uncared for. The new king, Joseph Bonaparte, provided her with a small income, but made her utterly wretched by refusing to continue the sentinel who had always mounted guard at her door. Over and over again she petitioned and passionately pleaded for this privilege, the want of which was breaking her heart, and injuring her health to a really serious extent; when some one proposed a wooden figure in a soldier's uniform, musket and all complete, to be mounted as guard at the inner door of her old house at Portici. The idea was adopted, and actually restored the old lady to health and cheerfulness, until the effect of passing it repeatedly without receiving the usual salute began to prey upon her mind, when she fell ill and soon after died. Ten years after travellers saw the wooden figure still standing sentinel by the outer door of the apartments she had occupied.

STRANGE FULFILMENT OF A CURSE.

For the following remarkable story we are indebted to an old pamphlet and to Dr. Darwin, who states that it was told of a young Warwickshire farmer who lived in the seventeenth century. He concealed himself, to detect a thief who was breaking his hedges for firewood, on a moonlight night under a haystack. It was very cold and he felt the frost severely, but patiently waited until midnight, when an old woman appeared, evidently, as he believed, a witch, who made herself a faggot from his hedge, and was about to make off with it when he sprang out and seized her. A struggle ensued, at the end of which the old woman stretched forth her withered arms to the moon, and cried solemnly, "Heaven grant that this cruel man may never again enjoy the blessing of warmth!" The half-frozen farmer was so terrified that he abandoned his captive and hurried home. Day by day, and night by night, he grew colder and colder, and was never seen without several coats upon his back, one over the other; he was always shivering, and always complaining of cold; and although he lived for twenty years after, the popular belief was that the cold ever increased in intensity until at last it touched his heart and froze it. Dr. Darwin relates this as a curious illustration of mania arising from an overwrought imagination.

FOSSIL FOOTPRINTS.

The footmarks of an animal on soft mud or snow are objects people are quite familiar with, and they know how evanescent they are—here to-day, and gone to-morrow—a quality which the poet had in mind when he compared the perishable worldly record of men's deeds to "footprints on the sands of time." It would then be a wonderful thing if footprints could be found which have been preserved more thousands of years than such impressions usually last for hours: that have, indeed, been kept intact so long that the very kinds of animals which stamped them have died away and become extinct. And such is one of the wonders revealed by geological research, for footprints have been found which were made on the sands of sea-shores of ages ago, the impressions having, by a favourable combination of circumstances, been preserved for probably millions of years!

The earliest discoveries of these long-hidden footprints caused perhaps the most astonishment.

Fig. 1.—FOSSIL FOOTPRINTS.

In this country they were first found at Storton quarries, a few miles from Liverpool, on the Cheshire side of the Mersey. In the year 1838 the quarrymen found some singular imprints on the whitish sandstone, which looked like the impressions of a thick, fat hand (Fig. 1). There were the depressions caused by the four fingers, and also accompanying these, a remarkable mould of a thumb pointing inwards, just as one would suppose they would be left by a man planting the palms of his hands on a yielding surface as he crawled along. This was the idea the workmen had, for they took them to be the marks of "some one crawling away from the Deluge." There were two sizes of footprints laid bare, the lesser being of about half the length and width of the larger; and the geologists thought that they belonged to some four-footed creature up to then unknown, not a bone of it having been discovered.

Similar footmarks had already been found at Hesseberg, in Saxony, on the surface of sandstone slabs. The larger footmarks, which appeared to belong to the hind feet, were about eight inches long and five inches wide, and one impression was as much as twelve inches in length. There were also a smaller series of footprints here, of about half the size of the larger ones, which were at regular distances of about an inch and a half from them, and in front. The unknown animal which made them was provisionally named the *cheirotherium*, from its hand-like footmarks.

The cheirotherium had evidently a wide distribution, as its footprints have since been found in numerous places in the Old and New Worlds. At Lymm, in Cheshire, they have been found with those of birds and the small pointed impressions of crustacea; they have also been seen in the coal-measures of Greensburg, in Westmoreland county, Pennsylvania, and in other places.

Now, there can be not the slightest doubt as to the genuineness of these footprints on the sandstone. Every circumstance of their position and accompanying impressions of other kinds go to show that they were made when the rock was soft sand or mud, which was afterwards dried and hardened by processes the geologist has familiarised himself with as far as ascertained facts will permit. The Greensburg fossil footprints are even distorted slightly by the cracks made when the material on which they were impressed afterwards dried and shrank. The footprints were evidently made, too, on the shores of seas, and are often accompanied by the ripple-marks one so often sees left on the sands when the sea has receded. A wonderful record sometimes also accompanies them of the showers which fell while these creatures were unconsciously leaving us the vestiges of their existence, for as each drop of rain fell it made a circular depression in the mud, the very shape of which is sufficient to tell the direction of the wind at the time!

Fig. 2.—LABYRINTHODON AND FOOTPRINTS.

Fig. 3—LABYRINTHODON RESTORED.

With these convincing proofs of the genuine nature of the footprints made by some unknown creature ages ago, just as certainly as the footmarks on the muddy street are made by the horse which has traversed it, geologists were not slow to speculate as to its form. The cheirotherium was evidently an air-breathing animal, otherwise it could not have made the impressions, for a certain depth of water would have buoyed it up: it was also an animal with its fore feet considerably less than the hind ones, and with the inner toes (thumbs and big toes) directed inwards. These were the few facts on which they based their speculations; there was not a bone nor a tooth of it found, and it is not surprising, therefore, to find some divergence of opinion as to what the cheirotherium was like. One had the idea that it was a kind of kangaroo, as such an animal would satisfy most of the required conditions, being an air-breather, having smaller fore feet than hind feet, and having the great toe (thumb) of the fore foot turned away from the others. Another supposed the tracks were made by a gigantic frog-like animal; while a third was disposed to believe they were left by a species of crocodile. The frog-form hypothesis was subsequently favoured by Professor Owen, who conjectured the cheirotherium was one and the same as the labyrinthodon, whose remains he had examined. The labyrinthodon was frog-like in general form, possessed teeth, was an air-breather, and had its fore feet smaller than its hind feet; and to these latter facts we have to add that it lived at the time when the footprints we speak of were made. It therefore appears not improbable that the cheirotherium was the labyrinthodon; and Fig. 2 is Professor Owen's idea of the creature as it crawled on the beach, and produced the hand-like impressions which so surprised the Cheshire quarrymen. Our third illustration represents the creature more perfectly, as it may be supposed to have existed amongst the surrounding scenery of its own geologic age. The teeth of the labyrinthodon, when examined in transverse section, present a very curious and tortuous pattern; whence the name given to the extinct animal. It was one of the extraordinary reptiles which once lived in this land.

The cheirotherium, or labyrinthodon, is not the only animal which has left its footprints behind it. Footprints of bipeds and quadrupeds have been found in great abundance at Turner's Falls, on the Connecticut River, Massachusetts, which have been identified as those of birds, lizards, tortoises, and frogs. The tracks have been found north and south of Turner's Falls for an extent of about eighty miles, but the Turner's Falls quarry is generally regarded as the great repository of these geological treasures, and they are now worked at extreme cost and labour for the specimens. Some of the slabs on which the footprints occur are valued at £100 to £200. The quarry has been visited by many distinguished authorities, including Sir Charles Lyell and Professor Huxley. Sir Charles Lyell was much struck with the general likeness of these impressions to some of recent origin which he had seen on the shores of the Bay of Fundy. He had there minutely examined the pitted appearance produced by falling raindrops, the ripple-marks made by the wavelets, and the three-toed tracks left by a sand-piper; and here, in the Connecticut sandstone slabs, he saw the similar impressions made by the raindrops of hundreds of thousands of years ago; the ripple-marks produced by a vanished sea, and the clean-cut and finely-moulded imprints made by the feet of creatures which have been extinct for ages.

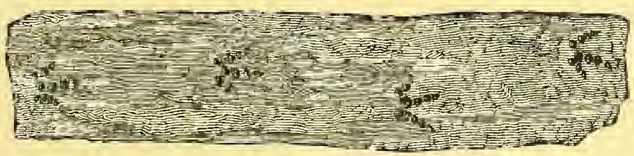


Fig. 4.—BIRD FOOTPRINTS, FROM CONNECTICUT.

The bird tracks are of singular interest, and some of them of such an extraordinary size that the bipeds which produced them must have had feet four times as large as the living ostrich, and the animal may have towered to a height of twenty-five to thirty feet! In some of the lesser tracks there is great uniformity and singular delicacy of detail. If one follows a given track, each footmark is at a regular distance from the others, and what corresponds to the great toe is pointing inwards. The biped footprints are mostly of a three-toed character, and show the articulations wondrously well, although there are some where there is evidence of a fourth rudimentary toe directed backwards. Sometimes specimens have been obtained in which even the impression of the skin of the foot has been retained, and from the skin markings of one of these footprints Owen decided that it belonged to a bird of the ostrich kind, and not to a reptile. Such a conclusion is, however, received with some reservation when the geologist remembers that the iguanodon, although a reptile, had many ostrich characteristics, and some large three-toed footprints found in the Hastings beds near Cuckfield have been conjectured to be the impressions produced by an iguanodon's hind feet.

Another fertile mine of footmarks of extinct animals has been found in the deposits of marl separated by masses of gypsum in the valley of Montmorency, in the neighbourhood of Paris. This marl, before hardening, is thought to have been the shore of a lake, and there are footprints on it of both bipeds and quadrupeds, including tortoises, crocodiles, iguanas, and geckos. There are also the impressions made by a huge wading bird of the size of the ostrich.

It has been well remarked that these footprints give to us new and unexpected proofs that the animal life of what geologists term the Upper Eocene period in Europe far surpassed in the number and variety of its kinds the largest estimate which had been previously formed of it. Indeed, they create the impression that our ideas of past life derived from the actual teeth and bones of animals which we have taken from their burial-grounds, the earth's strata, may be very incomplete, and that in the ages past there may have existed as many different life-forms, since become extinct, as there are on the earth now.

TIME-KEEPING EXTRAORDINARY.—The Swiss journals state that a watch and clock maker at Vouvry, having furnished two watches with mechanism invented by himself, placed them in a box, which he confided, on the 16th January, 1879, to the municipal authorities of that town, by whom it was sealed and deposited among their archives. Upon the official opening of the box, which took place two years afterwards, the two watches were, it is said, found to be still going regularly.

THE SAINT VINCENT VOLCANO.

THE Caribbean Sea has been described by Humboldt as forming, in connection with the Gulf of Mexico and the great plain of Louisiana, one great ancient basin. This basin is traversed through its centre by a plutonic range of mountains from Cape Catoche in Yucatan to the islands of Tortola and Virgin Gorda. The range extends through Cuba, Hayti, and Porto Rico; and lying parallel with it is the granite and gneiss chain of Caracas in the South. On the eastern side lie the Antilles, containing the large, but now extinct, volcano of Eustathius; the active "Souffrières" of Guadaloupe and St. Lucia, the "Boiling Lake" of Dominica, and the Volcano of St. Vincent. These, whether active or quiet at the present hour, are witnesses of the mighty forces which in former times have wrought such changes, and which may in coming years prove once more how powerless man is in the presence of nature working under its appointed laws.

There are few objects in the West Indies of greater interest than the Volcano of St. Vincent, known locally as the "Great Souffrière." It is now quiet, and has remained so during seventy years. The famous earthquake which overthrew Caracas, the capital of Venezuela, on March 26th, 1812, found its vent at this spot in the following month. Indeed, this volcano, with that of Guadaloupe, seem to have been for long ages the safety-valves of the immense area embraced by the plains of the Orinoco and the entire Caribbean Sea.

The mountain is situated in the north-west of the island, about fifteen miles from the capital. A walk of six or seven miles from the hamlet on the sea-shore at its base takes the traveller to the edge of the Old Crater. Standing here, the edges rise as they recede to the right and left, until they meet on the opposite side at the distance of nearly a mile. The walls of the crater are 500 feet above the waters below. The lake forms an almost perfect circle; a few tiny headlands prevent the outline becoming monotonous. The waters of the lake are bluish-green in colour, due to the quantity of sulphur with which they are impregnated, and the lake is 600 feet deep. In some places the walls rise sheer, in a few spots the descent is less precipitous, but great caution must be exercised by those who are ambitious to reach the surface of the water.

When clouds brood on the summit of the mountain the grandeur of the place is very impressive. At one moment the dense mist falls into the crater, as it were, by its own weight, and completely fills the immense hollow. A great gust of wind now sweeps down, and clears out the cavity in five or six seconds; the mist rises as though urged by some force beneath, and is torn over the edge, flying, as it seems, from the face of the storm fiend; light wreaths of mist still clinging to the rugged sides. The scene then changes. The cloud now conceals the higher edges, and leaves the space below clear and distinct, a soft and brilliant light being thrown on to the water far below. The sunlight struggles through the haze above, and a shaft of golden light steals slowly across the silvery waters and up the weather-beaten cliffs.

A further walk of about two miles leads to the New Crater, formed in the mountain-side by the eruption in 1812. A "saddle ridge," so narrow that only a person of strong nerve would venture on it, separates the old and new craters. The latter is not so grand and awe-inspiring an object as that already described, but its sides are torn and rent, and are rugged and appalling enough; the bottom being covered with dark ashes, sand, and reddish water. It must also be remembered that its formation was effected not in the slow lapse of ages, but by a sudden and frightful convulsion in the present century, the story of which catastrophe may be told as follows:—

On Monday, April 27th, 1812, men say that a sudden rumbling was heard in this part of the island. A huge column of smoke was seen to ascend from the mountain, and enormous quantities of volcanic dust and ashes were discharged. Next day the vapour which overhung the summit rose to an immense height, continually expanding as it rose, as though rejoicing to be free from some intolerable confinement, while at the same time a dense mist came down and overshadowed the mountain and north shore of the island. That night fire was observed glowing from the crater, and brightening the clouds overhead. The rumblings went on increasing, and strange vibrations began to be felt. On the 30th April, these noises became yet louder, and to persons at sea they resembled the cannonade between two powerful fleets. As that night came on, sheets of flame burst upwards, followed by incessant thunder, and electric flashes played amid the darkened vapour. At this time streams of fiery lava were vomited forth, masses of red rock were shot upwards, and the lava, boiling over the edge of the crater, carried everything before it, until it plunged into a deep valley, and, thence gaining an outlet, it rolled its fiery flood onwards to the sea, which it reached in four hours. The confusion on land and sea and in the air that night, the thunderings of the mountain, the roar of the moving mass of fire, as it scorched up the woods and split the rocks in its onward course, and the hissing contact as it plunged into the ocean, became so fearful that despair seized on all.

It was about this time that the earthquake first added its terrors to the other horrors. The part of the island where the mountain is situated seemed to be in constant agitation, as though the land were swimming in a troubled sea. So passed that dreadful night, and day—if day it could be called in which no light of sun appeared—broke on the troubled scene. The island and the sea for many miles around were overshadowed by a gloomy haze. The entire island lay covered with scoriæ and ashes, which lay in places to a depth of fourteen inches. In the afternoon the voices of the mountain became gradually silent, and except when subterranean rumblings are heard in the stillness of the night, and terrify the inhabitants who dwell near its base, those voices have remained quiet for over seventy years.

A remarkable circumstance occurred during this eruption. So prodigious was the quantity of volcanic matter thrown out during its continuance, and to so great a height did it ascend, that it was carried *eastward* above the region of the continuous trade wind, and fell thickly on the decks of ships sailing 600 miles to the east of the island. At Barbadoes, which lies nearly 100 miles dead to windward of St. Vincent, it was deposited in some districts to a depth of six inches; and to the present hour the coloured population of Barbadoes are accustomed to date local events of interest as so many years before or after the "Year of the Dust."

ROMAN WAR-ENGINES.

NO change could well have been greater than that effected in the nature of instruments of warfare by the invention of gunpowder, but for which little progress would probably have been made in the art of killing, even to our own times. Before the knowledge of the death-dealing powder came to the possession of Europe, the weapons in use were generally such adaptations of primitive ideas as may yet be seen amongst savage tribes. Spears, javelins, bows and arrows, swords, daggers, maces, and axes—these were the slow but natural growth of one thing out of another, such as is always going on both among civilised and barbarous races; and but for the invention of gunpowder, we might still be using weapons differing but little from those familiar to our ancestors at Hastings, at Creçy, and at Bannockburn.

Perhaps by no people was the art of war better understood, or more perseveringly followed, than by the bellicose Romans of old. That the arms which they habitually carried were very similar to those also in use amongst the Greeks, and later amongst the Barbarians who ultimately overthrew the great Roman Empire of the west, we are well aware. Their swords and shields, their bows and arrows, their slings, spears, cross-bows and bolts, are more or less familiar to us, partly from descriptions contained in the classic writers, and to no small extent also from an examination of the objects themselves, which, after an interval of more than one thousand years, have returned to teach us something of that old Pagan world. But besides these small arms, as they may be called, the Romans possessed, as time went on, sundry more imposing weapons, to which doubtless they were not a little indebted for their success in war, and particularly in the reduction of fortified towns.

Amongst these various machines those to which the name of *tormentum* was applied were perhaps the most formidable. As a general rule the projectiles used by the Roman soldiers were thrown by the hand, though the sling was a favourite weapon, and bows and arrows were even more in vogue. But such weapons as these were of little service except in the open ground, and in the operation of a siege the tormenta were brought into play with immense effect, if we may judge by the tales of historians. These tormenta were of the kinds known as *catapultæ* and *balistæ.* The name was derived from the fact that the machine was worked by means of twisted hairs, thongs, and vegetable fibres. By means of the catapult volleys of darts and javelins, some of which, known by the name of *trifax*, were as much as 4½ feet in length, were hurled with great force and precision against an opposing force; while from the balista could be projected either similar darts of much greater size, or huge masses of stone, sometimes reaching as much as three hundredweight in weight. The size and power of the balista, however, varied greatly, and while the sizes apparently mostly in use were constructed to throw stones of half a hundredweight, one hundredweight, and three hundredweight, yet many smaller engines are mentioned, some of which threw stones of not more than two pounds in weight.

Notwithstanding the many descriptions of these instruments to be found in the ancient authors, and that they are even to be seen depicted upon the column of Trajan, some doubt seems to have been entertained as to the exact mechanism by which the projectiles were hurled forth. While the late Emperor Napoleon was engaged upon his "Life of Cæsar," however, the matter was very carefully studied, bas-reliefs and all accessible information being consulted; and from these studies models were afterwards constructed by M. Maitre, which have since been placed in the Museum of St. Germains. Two of these interesting restorations are shown in the illustrations. The balista shown in Fig. 1 and the catapult seem to have been very similar machines, and to have been practically immense cross-bows; indeed, remembering how long the Genoese were celebrated for the latter weapon, there is good reason to believe that they may have inherited it in this portable shape from their Roman ancestors. In M. Maitre's balista the bow itself is however replaced by separate levers, M N, each fixed in a compact bundle of intensely-twisted cords and sinews, O P. The cord, C, cannot possibly be stretched by hand, but is drawn along the body, R, by a windlass, till fixed to the hook of the trigger. The arrows (1, 2) are about 4½ feet in length, and have been thrown by the St. Germain's model nearly 400 yards, while a wooden target has often been pierced through and through. The darts or arrows are guided by a groove in the top surface of the stem or body ; but it is believed stones were laid on a broader surface. So great was the power of the larger balistæ as perfected by the Romans, that large stones are said to have been thrown a quarter of a mile.

There was a smaller machine called the *onager*, in which the principle of the sling was brought into play, and a carefully-executed restoration of this is also at St. Germains, and is shown in Fig. 2. A strong wooden lever, A, is fixed at one end, as before, in a mass of tightly-twisted cords and tendons mounted in a massive framework, and twisted severely so as to give an intense rebound whenever released. This twist is further increased by drawing back the lever to the position shown, which is done by a lever capstan, when it is held by the cord, C, and hook-trigger, B. To the top of the lever is attached the sling, F. After release the lever strikes against the cushion of wool, shown at the other end of the machine. The balls thrown by the onager ranged up to over 6 inches in diameter, and even the St. Germain's machine projected them nearly 200 yards. The sketch at the top represents part of another bas-relief from the column of Trajan.

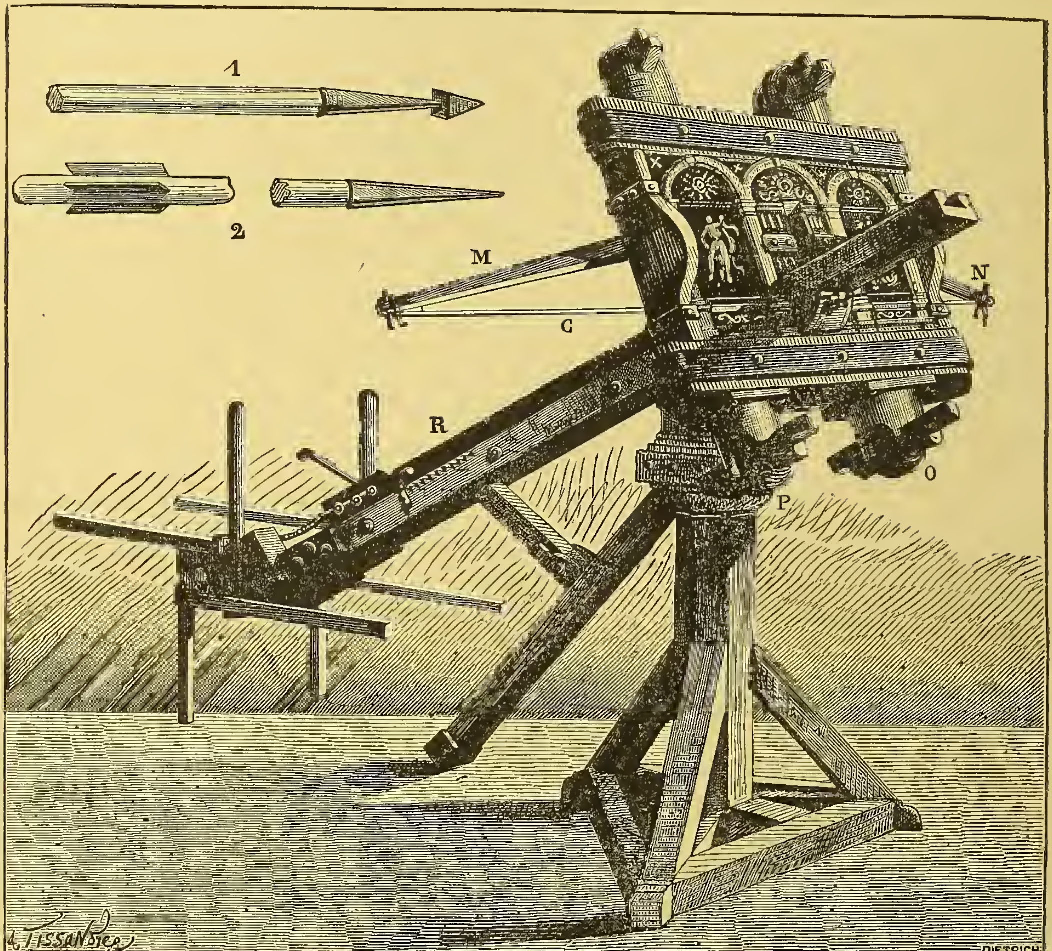


Fig. 1.—BALISTA, FROM THE RESTORATION IN ST. GERMAINS.

These weapons do not seem to have been invented until shortly before the time of Alexander the Great (about 350 B.C.), but soon came to occupy an important place in the furniture of an army, and were generally drawn up in the rear of an advancing force, so that the missiles could be hurled at an opposing enemy over the heads of the forward ranks. They were also sometimes employed in attacks upon maritime cities, when they were carried upon the decks of vessels specially constructed for their use. Generally the various forms of tormenta were used together, so that, while the balistæ were reducing the battlements of a beleaguered town, the catapults served to launch volleys of arrows against any of the besieged who might appear in the gaps; and Cæsar tells us that, so great was the value of the tormenta, when the supply of horse-hair and other material failed, the women in some instances cut off their own hair and twisted it into ropes, that no interruption should occur in the working of the engines. Sometimes the catapults and the balistæ were combined in the same engine, and of such construction were the towers known by the name of Helepolis, or "the taker of cities," the first of which was employed by Demetrius Poliorcetes in the siege of Salamis. The Helepolis was a tower of several storeys, protected upon the three sides open to attack when facing an enemy by plates of metal, in which were sundry portholes, which could be opened and closed at pleasure. Hence were discharged the missiles of the catapult and the balista; and in later times, under its protection, the battering-ram was brought to bear upon the walls of a besieged city. It was by the aid of such towers that the walls of Jerusalem were destroyed, when the Holy City was taken by the Romans.

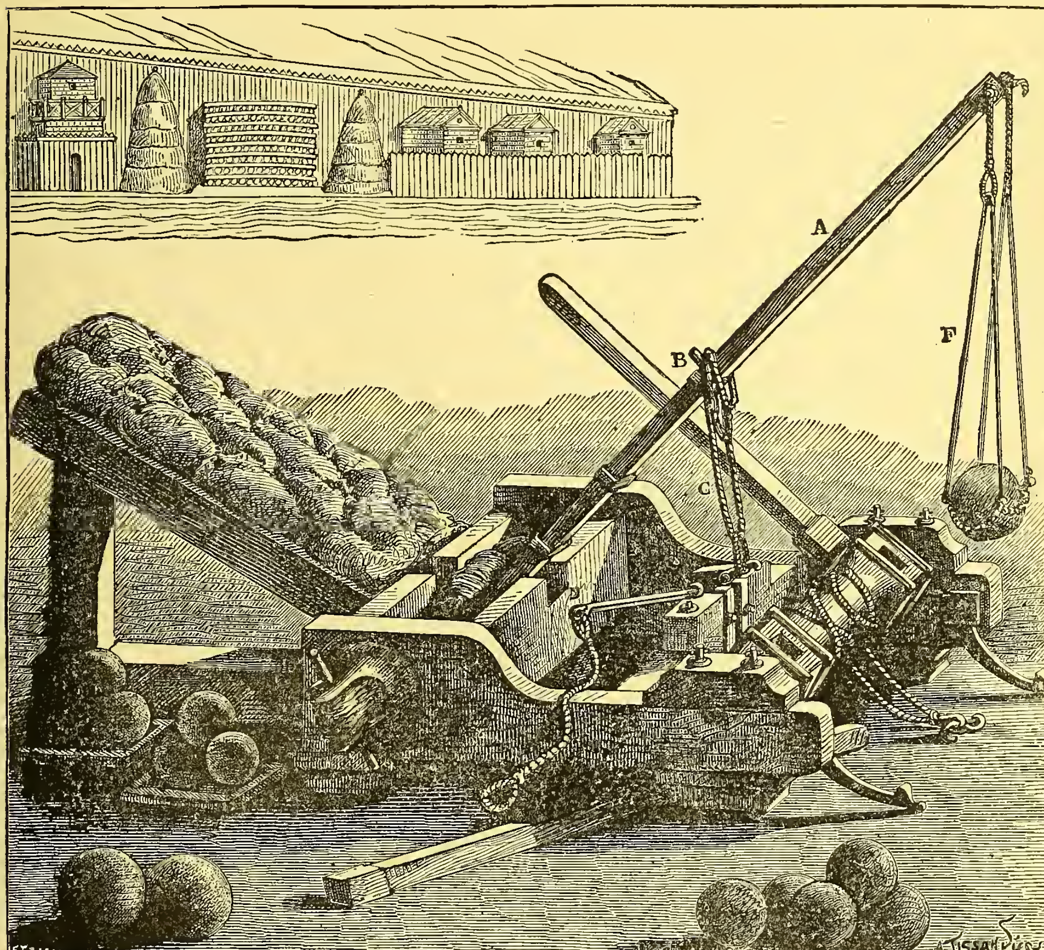


Fig. 2.—ONAGER, FROM THE RESTORATION IN ST. GERMAINS.

The battering-ram above alluded to was a favourite and almost indispensable engine in the hands of the Roman army. It was used to shake, shatter, and destroy the walls of beleaguered cities, and amongst the Romans went by the name of *Aries*, the Ram, from the resemblance of its action to the butting of a ram, and also from the fact that its head consisted of a mass of bronze or iron, which was generally fashioned into the figure of a ram's head. The aries consisted of a large beam, generally of fir or ash, headed, as has been said, with a mass of metal, and in its simplest form was carried by a number of soldiers, and impelled by human hands alone, being directed when possible against the angle of a wall, which would of course be the most vulnerable point of attack. As time went on improvements were made in the construction of the aries, and it was surrounded by iron bands in which rings were fixed, so that by means of chains or ropes it could be suspended from a transverse beam above, and thus relieve the operators from the burden of its weight. Thus suspended it was easy to impart to it a quick and powerful motion backwards and forwards, and Josephus declares that "there was no tower so strong, no wall so thick, as to resist the force of this machine, if its blows were continued long enough." It must have been indeed a formidable engine, and was often as much as 80, 100, and even 120 feet in length. Frequently the frame on which it was suspended was carried upon wheels, while it was protected by a wooden roof or *testudo*, which afforded shelter to the besiegers when beneath the walls of a hostile town. It might seem that the great length to which the aries sometimes reached would render it unwieldy to a serious degree; but in fact the longer rams had many advantages over the shorter ones. The increase of weight and consequent power was of course to be considered; and, further, by means of the long ram it was possible to act across an intervening ditch, while in other cases those who worked the machine were able to remain in comparative security at its farther extremity, and sheltered by the roof from the showers of stones and other missiles hurled upon them from the battlements. Upwards of a hundred men were sometimes employed in working a single ram, and there can be no doubt that success very generally attended their efforts. But the besieged were not without means of defence. They threw down burning material, in the hope of setting fire to the ram, and also cast from the battlements huge masses of stone, wood, and metal, by which means they endeavoured to break off the metal head which did so much damage to their walls. They sometimes succeeded, too, in catching the aries in a noose or in a large forceps, and by this means overturned it; but the besiegers generally contrived to cut the ropes of the noose, before damage was done, with the sickles with which they were purposely armed. As a further defence, the besieged were accustomed to fill sacks with chaff and other soft material, which they lowered down to intercept and break the force of the ram; but the ropes to which the sacks were attached were of course cut by the sickles of the besiegers, and generally the walls, once attacked by the plodding aries, were doomed to at least partial destruction.

There was of course no little danger in approaching the walls of a hostile city for the purpose of gaining a footing on its ramparts, and the besiegers were met by showers of stones, arrows, darts, and even more terrible missiles. To defend themselves from these, they were accustomed to form with their shields a *testudo*, or covering, of the strength of which very extraordinary stories are told. The shields fitted closely together, and thus formed an unbroken surface, which was presented to the enemy sometimes in a horizontal, but more generally in an oblique position. It is related that the testudo was so firm that men were able to walk safely over its surface, and even horses and chariots had at times been driven over it.

As with so many nations, war chariots were in use amongst the Romans from the earliest period. One of these, in a tolerably perfect state, is still preserved in the Vatican. It is, like all forms of the *currus* or chariot, constructed to carry two persons, one of whom, standing, held the reins. The wheels were over four feet in diameter, and were retained upon an oak axle fixed to the bottom of the chariot by means of linch-pins. The stability of the chariot was often increased by lengthening the axle-tree, and thus widening the base of the chariot. The horses, generally two in number, were harnessed by means of a yoke; and should it be desired to add to the number of horses, the additional one or two were generally attached by means of traces only. The Roman chariots do not themselves appear to have been armed, though Cæsar describes those of the ancient Britons, with scythes attached to the axles of the wheels; but we can nevertheless believe that a series of such chariots, drawn by spirited horses and manned by the flower of the Roman legions, would create not a little havoc amongst at least a barbarous and ill-armed enemy.

A Remarkable Journey.—An extraordinary tricycle journey was accomplished by the Vice-President of the Lyons Bicycle Club, accompanied by his wife, on a two-seated "machine," in May of 1882. The travellers went from Lyons, through Nice, Genoa, and Rome, to Naples, returning *viâ* Florence and Turin, the whole journey, representing a distance of some 2,300 miles, being accomplished at an average of about fifty to sixty miles for each day on the road.

ELECTRIC INCANDESCENT LAMPS.

THERE are now so many systems of electric illumination before the public, that the non-technical observer is puzzled to understand in what features they differ from one another. Gas he is accustomed to, and the manner of using it is so simple that he has little to learn about it. It represents but one system, by which the gas is conveyed to a burner by a pipe, where it bursts into flame when a light is applied to it. But whatever the difficulty may be in pointing out the different features exhibited by competing systems of electric illumination, they can all be gathered together and sorted into two grand divisions—arc lights, and incandescent lights. The first of these we have already considered, and to the second we now direct our readers' attention.

Let us first of all imagine that we have before us a small battery consisting of, say, five Bunsen cells, joined up zinc to carbon in the usual way, with two terminal wires from the first and last cell, for the convenience of making a few experiments. If we connect these two electrodes by bridging them across with a couple of inches of thin iron wire, this will—by the resistance which it offers to the passage of the current—become red, and then white hot, and will fall down in melted globules. A platinum wire treated in the same way will last longer, and will give out a brilliant white light for some time before it actually fuses; or, if the length of wire, and the strength of current can be nicely adjusted, it will not melt, but continue to glow. A silver wire of the same thickness will not even get hot; it is such a good conductor that it offers little resistance to the passage of the current. A slender stick of carbon will behave like the platinum wire; it gets white hot, and gives out, by its incandescence, a brilliant light; but, sooner or later, it combines with the oxygen of the atmosphere, forming the gas called carbonic dioxide, and crumbles away. Now all systems of lighting by incandescence can be readily understood by reference to these simple experiments. They depend upon the fact that an imperfect conductor, placed in an electric circuit, manifests its resistance by giving out light and heat.

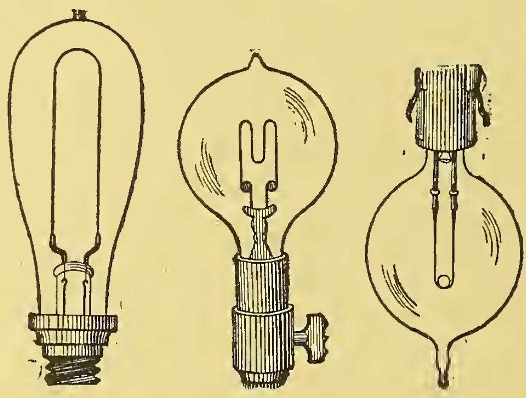
All substances which show this action—as far as we know at present — are however more or less gradually affected by the oxygen present in the atmosphere, and speedily waste away. With the aim, therefore, of keeping this oxygen from them, they are protected by a vessel of glass from which the air has been withdrawn. Long before the magneto-electric machine was brought to any kind of perfection, a lamp on this principle was patented by E. A. King. The object which this inventor had in view was to produce an electric lamp, on a small scale, fit for domestic purposes. The arc-light he knew well enough gave out a brilliance far too great to be of any service, except for out-door use, or for the illumination of large areas. His lamp, as described in the patent specification, dated 1845, consists of a couple of rods with forceps attached, between which is held a narrow strip of platinum foil, which is rendered incandescent directly the current passes through it. By certain arrangements which need not be described, the current is so adjusted that the melting point of the metallic strip is never actually reached. The platinum foil can be replaced by a stick of carbon, and the whole arrangement is enclosed in a glass bulb, from which the air is pumped out. In 1846, Greener and Staite patented a lamp of similar structure; but they were very careful to use carbon of greater purity, and their specification gives directions how this can be attained.

For twenty-five years the matter slept, until, in 1871, the incandescent system of lighting came to the front again, and a company was formed at St. Petersburg in order to give it success. Those who are under the impression that incandescent lamps are new contrivances will be surprised to learn that at this date 200 lamps were shown in action upon one circuit. This remarkable and suggestive experiment was carried out by M. Lodyghin, at St. Petersburg, with an Alliance machine (see p. 164) and it was thought so successful that the company just spoken of was formed to give it commercial shape. The excitement at the time was extreme, and there were no doubt many then—as there have been since—to prophesy that the days of gas were numbered. But the scheme failed. The money subscribed disappeared in repeated failures; but the lucky inventor was voted—all too soon—a prize of 50,000 roubles by the Academy of Science.

One year later we find another Russian, Konn, who patented arrangements of a similar kind. His lantern he describes as being "hermetically closed, and filled with nitrogen or other gas that does not support combustion." In this receptacle were so arranged little strips of carbon, that as soon as one wasted away another became incandescent. This lamp he afterwards modified into a form so like the incandescent lamps of to-day, that it is a very interesting thing to look back upon. It consists of a glass globe exhausted of air, and having sealed into it two wires, between which is supported a carbon pencil, which the passage of the current makes incandescent.

The incandescent method of electric lighting remained without exciting any particular attention until Dec. 12, 1879, when one of those startling telegrams, which we have learned to associate with the name of Edison, was flashed to this country from New York. As this telegram marks an era in the history of electric lighting, we will reproduce that part of it bearing upon the subject under review. "Mr. Edison has perfected an electric lamp of extraordinary simplicity, costing only 25 cents, with which he proposes a general illumination of the village of Menlo Park on New Year's Eve. He has discovered that a steady brilliant light is obtained by the incandescence of mere carbonised paper, better than from any other known substance. Strips of drawing-paper, in horse-shoe form, are placed in a mould, and baked at a very high temperature. The charred residuum is then attached to the platinum wires, and hermetically sealed in a glass globe, from which the air has been exhausted. This, attached to a wooden stand, or ordinary gas fixtures, is the whole lamp. No regulating apparatus is required, the flow of electricity being automatically increased and diminished at the central generating station."

That this telegram made a great sensation there can be little doubt, and most likely it had the effect which it was intended it should have, in affecting the operations of the Stock Exchange, but it is only fair to state that Edison himself had no hand in this, or in any of the more wonderful telegrams which have reported his doings. Another effect of the news was a rush to the Patent Office by successful and non-successful inventors, so that they might search the specifications relating to incandescent lamps to see how the ground actually stood from a patent agent's point of view. The old specifications of King, Greener, and Staite, already quoted, with many others, were almost learnt by heart by those interested, but all acknowledged that although Edison appeared to have achieved a success, there was nothing new in enclosing a carbon filament, and rendering it white hot in a vacuum; the only difference in the merits of the case was that he had succeeded where others had failed. It is now well understood that these former failures were due principally to a want of the means to secure anything approaching to a perfect vacuum; and also, perhaps, to ignorance of the fact that carbon contains within its pores large quantities of gas. This gas, when the carbon is rendered incandescent, is evolved, and acts upon the solid in such a way that it is worn to powder, only less quickly than if it had been rendered white hot in ordinary air. We will now briefly describe the mode of manufacturing the modern incandescent lamp, when we shall see how this last difficulty is overcome.



EDISON. MAXIM. SWAN.

Fig. 1.

First, with regard to the thread of carbon, to the incandescence of which the light is due. This may be made either of some vegetable fibre in its raw state, or after it has passed through a process of manufacture. As we have seen, Edison, in his first lamp, made use of paper; we believe that he has since found bamboo fibre to be more durable. We may also feel quite sure that every material capable of yielding a thread after being carbonised has been tried by that busy inventor. The carbonising is effected by packing the raw material with powdered carbon into a crucible, and exposing it to the heat of a furnace for a certain time. The carbon filament is then, by some lamp-makers, put through a further process. It is placed in an atmosphere of some hydro-carbon—such as gasoline—and while it is rendered white hot by the passage through it of an electric current, an additional amount of carbon is deposited upon it. In this way its thickness may be accurately controlled, variations in its structure made good, and its electrical resistance made equal to a standard. The thread is now attached to its wire supports, and is ready for introduction into the little glass globe which is to serve as its protector from the air. When sealed in its place by the glass-blower there is still an opening in the globe from which the air can be exhausted by means of one of those improved air-pumps, such as that of Sprengel, which are of such value to the modern inventor. Whilst the pump is at work exhausting the air, the carbon filament is rendered incandescent, so that the gas evolved by the carbon may also be drawn away, and this, with care, is accomplished. But it is not uncommon to see lamps which have been in use for some weeks with a fine coating of carbon upon the inner surface of the glass, showing that gas or air is causing a disintegrating action.

Fig. 1 shows three of these lamps, which differ from one another chiefly in the shape of the carbon thread; and this is, in point of fact, the only real difference which exists between the multitude of patterns now before the public. There would be great difficulty in deciding to whom the patent rights belong, and inventors will probably be content to leave it an open question. Swan's lamps are now in great demand in this country, and they probably represent the most perfect form. The most usual size for domestic use is that affording a light of 20 candles ; and, as a rough estimate, it is stated that every ten lamps require one horse-power, but this is, of course, greatly influenced by the number of lamps in use, as we shall presently see. As in the case of arc lamps, any source of power may be used to drive the dynamo machine to feed incandescent lamps, but with one exception, gas engines cause a kind of pulsation in all the lamps deriving their energy from a machine driven by one, and this pulsation not only affects the electric lamps, but will cause all gas lamps in the vicinity to jump in unison. This jumping is, of course, caused by the small explosions of gas and air which form the leading feature of such machines. Very different from the arc lamp, with its ghastly white, or rather, blue-white glare, the incandescent thread gives out a clear and beautiful light, and one so soft that it can be looked at without distress. As the carbon is not in contact with air, no fumes are given off, and, therefore, the air is not contaminated as in the case of gas. The incandescent system lends itself willingly to the needs of modern decoration, and the little globes can be crowded together among artificial and real flowers, and in the midst of draped hangings, without any chance of accident from fire. Such accidents are, indeed, with this form of lamp, quite impossible ; because, should the glass globe by any means be broken, the lamp is extinguished. Perhaps the most magnificent display of incandescent lamps ever seen was at the Electrical Exhibition at the Crystal Palace in 1882, where they were woven into designs of wonderful beauty. Fig. 2 shows a number of these lamps arranged as a basket of glowing flowers.

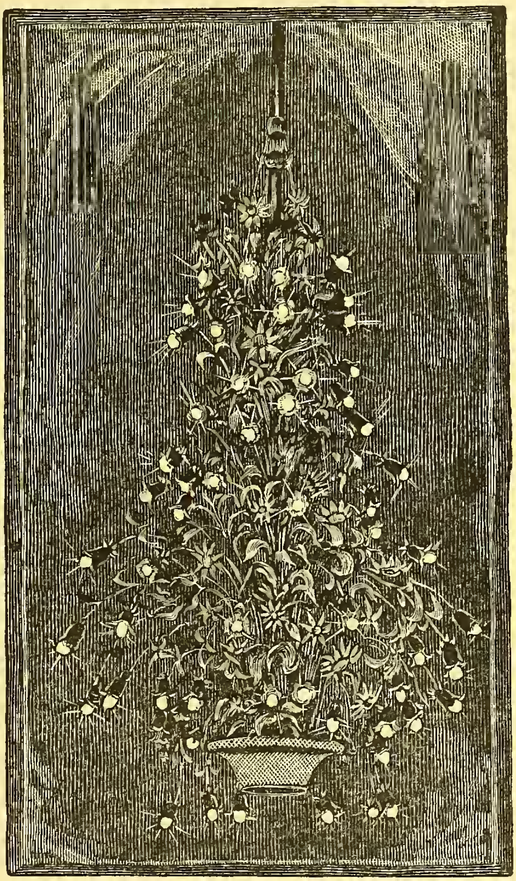


Fig. 2.—CANDELABRUM OF INCANDESCENT ELECTRIC LAMPS.

Perhaps the best way to learn the advantages or disadvantages of the incandescent system of electric lighting is to inquire how it behaves in actual practice. As it has now been installed in many private mansions, we are able satisfactorily to answer this inquiry. Among these installations, perhaps the most perfect is that of Sir W. G. Armstrong, at Cragside, Rothbury. This eminent engineer has the advantage of getting his motive power free of cost, since this is represented by a brook nearly one mile from the house. The brook is made to turn a turbine, which actuates a Siemens dynamo-electric machine. From this machine wires are led into the house to feed the lamps. The number of lamps is forty-five, and the force given by the distant turbine—estimated at six horse-power — is quite sufficient to light them up to their full extent, notwithstanding the great length of wire between machine and lamps. A library, 33 feet by 20 feet, is well lighted by eight lamps, four being clustered in a central globe suspended from the ceiling, and the rest placed on vases in different parts of the room. The electrical connections are so arranged, that the removal of a lamp from its vase immediately extinguishes it. A picture-gallery, also used as a drawing-room, is lighted by twelve overhead lamps, with eight additional ones, to which the current supplying the lamps of the dining-room can be shunted when that room is not in use. With this additional illumination, the pictures are as well seen as they can be by daylight. It is estimated that each single lamp in this country mansion is equal to a duplex kerosene lamp well-trimmed, or 25 candles, so that six horse-power, in supporting 37 lamps (the 45 are never required in use at the same time) gives an illuminating power of 925 candles. The same power applied to an arc lamp would give far more light, but could not be made available for domestic use, for that form of lamp is only divisible to a very limited extent.

As to the durability of the Swan lamp, we can obtain some information from its behaviour at the Savoy Theatre, London, after an experience of nightly use for many months. The lamps there were found to have a longer life than was thought possible when the system first came into use. After being in use—counting only the time during which they had been actually incandescent—four thousand hours nothing in their appearance was found to indicate that they might not yet double or treble that period.

A MUSICAL SLAVE PRODIGY.

MR. PERRY H. OLIVER, a tobacco-planter in Southern Georgia, bought, in 1850, a negro woman with a blind baby, then a few months old. Mr. Oliver was a kind master, who owned a great number of slaves, and had a large plantation. The blind negro child, as he grew up, was apparently idiotic, but gentle and obedient. He was permitted to squat about in the sun under the porches and verandahs of the house, and, out of pity for his forlorn and helpless condition, was treated as a kind of pet dog. He grew up a boy of the lowest negro type, coal black, with projecting heels, ape-like jaws, thick protruding lips, and a habit of throwing his head curiously far back, which added greatly to his imbecile expression.

One night, in the summer of 1857, Mr. Oliver's family were awakened by the sound of laughter and music, followed by applause, coming from the drawing-room. They listened with astonishment and wonder, full of strange feelings. Some player was evidently at the piano, and as evidently one with no mean skill. The touch, although timid, was singularly true and delicate. Who, or what could it be? Mr. Oliver hastily dressed himself stealthily, stole down the stairs, and noiselessly opening the door of the drawing-room, peeped in. Then the first mystery resolved itself into one still more extraordinary. The blind black boy Tom, who had been left sleeping in the hall, much as a dog or a cat might sleep, had got into the drawing-room. He was the nocturnal musician! He played not only the songs he had often heard played on the instrument—simple ballad airs—but some of the most difficult exercises played by Mr. Oliver's daughters, evidently in an ecstasy of delight. At the end of each successive passage he burst into shouts of laughter, kicking his heels, and clapping his hands. He was playing the piano for the first time in his life!

Naturally Tom became a nine days' wonder on the plantation. He was brought in to play when visitors came. The story spread far and wide amongst the neighbouring planters, who flocked in to listen, and went away wondering and perplexed. It was noticed that however the poor child's fingers strayed over the keys, cadences followed, broken, wandering, and startlingly full of beauty and pathetic feeling. The house servants used to cluster about the doors to look in at the strange, unsightly little face and figure of the black boy perched up before the instrument, from which he drew forth wild unknown harmonies, all touchingly expressive. From that time Tom was permitted to have constant access to the instrument, and was so unhappy when once kept away from it, that his health suffered. Old airs which people had forgotten, and which Tom could not have heard more than once before, he recalled, and reproduced with every note correct, together with entirely new combinations of harmonious sounds, quaint whims, and delicate subtleties, always sweet and tender, but always mournful, which breathed into the daily life of the old house a weird spirit of enchantment, generating even in the coarsest and most uneducated auditors feelings of deep pathos and tenderness.

No attempt was made to give the boy any teaching or scientific training. At last some musical friend suggested to Mr. Oliver that in Tom he had not only a prodigy, but a fortune, and it was determined to make an exhibition of his talent in public. He first played before the American public in 1858, at Savannah, in Georgia. From thence he was taken to Charlestown, Richmond, and thus, one after another, to all the chief towns of the Southern States, everywhere awakening feelings of intense astonishment and admiration. Sceptical musicians were allowed to subject the child to the most rigorous tests, and month by month his powers increased. It was said, at the time he was twelve years old, that he possessed a wonderful memory, but it appeared to be for sounds only. He would repeat a long discourse he had once heard, word for word, but evidently without any knowledge of its meaning. Songs he had heard sung in French or German he repeated in the same way, giving a curious imitation of each sound with perfect fidelity, although his voice was harshly discordant, and of small compass.

The concerts at which Tom played were excessively popular, and it was usual to include in them themes selected, at the suggestion of the audiences, from Italian and German operas. With regard to the mastery of his instrument, two points were specially noted—the unusually frequent adoption of *tours de force*, and the scientific precision of his touch. "In the progression of augmented chords," says one musician who witnessed his performance, "his mode of fingering was invariably scholastic, and not that which would appear most natural to a blind child who had never been taught music. Even when seated with his back to the piano, and made to play in that extremely awkward position—a favourite feat at his concerts—his touch is always accurate."

Again it was said : "Placed at the instrument with any musician, he plays a perfect bass accompaniment to the treble of music heard for the first time while playing ! Then taking the seat vacated by the other performer, he instantly gives the entire piece, intact in brilliancy and symmetry, not a note lost or displaced."

The selection of music by which Tom's power used to be tested sometimes extended to the length of fourteen or sixteen pages. On one occasion, when playing before the President of the United States at Washington, after a long concert, he was tried with two pieces, one thirteen and the other twenty pages long. He reproduced both with perfect success !

Some of the newspaper critics called Tom "The Blind Black Mozart," referring to Mozart's wonderful infantile manifestations of genius in music. Mozart, it may be remembered, at the age of nine, gave an accompaniment, without notes, to an aria which he had never heard before. One writer on his playing said : "When the music to which Tom plays *secondo* is strictly classical, he sometimes balks for an instant in passages ; to do otherwise would imply a creative power equal to that of the master composer ; but when any chordant harmony runs through it there are no 'false accords,' as with the infant Mozart. I wish to draw especial attention to this power of the boy, not only because it is, so far as I know, unmatched in the development of any musical talent, but because, considered in the context of his entire intellectual structure, it involves a curious problem. The mere repetition of music heard but once, even when, as in Tom's case, it is given with such incredible fidelity, and after the lapse of years, demands only a command of mechanical skill, and an abnormal condition of the power of memory ; but to play *secondo* to music never heard or seen implies the comprehension of the full drift of symphony in its current, a capacity to *create*, in fact. Yet such attempts as Tom has made to dictate music for publication do not sustain any such inference. They are only a few light marches, galops, &c., simple and expressive enough, but with easily detected traces of remembered harmonies, very different from his strange, weird improvisations of every day. One would fancy that the mere attempt to bring this mysterious power into bodily presence before the outer world stultified his idiotic nature, rendering it unable to utter its reproachful sweetness. Nor is this the only bar by which poor Tom's soul suffers restraint. After any too prolonged effort, such as those I have alluded to, his whole bodily frame gives way, and a complete exhaustion of the brain follows, accompanied by epileptic spasms." It is recorded that the trial at the President's house was followed by days of prostration and illness.

Being a slave, Tom was never, under the old *régime*, taken into one of the Free States, and for the same reason, Mr. Oliver rejected all the offers made to induce him to exhibit his musical prodigy in Europe. The outbreak of the Civil War, however, changed all this, and soon after 1860 Blind Tom was brought to England. Many will remember him as playing to crowded audiences in St. James's Hall, where he displayed the same wonderful powers, and excited as much astonishment among the many cultivated musicians of the metropolis as he had done in the Southern States.

Occasionally Tom was stubborn, and refused to play, and required to be coaxed and petted before he would take his place. He was always the first to applaud himself, and his loud, idiotic laugh, "Yah ! yah ! yah !" would clearly bespeak a vacant mind. On one occasion a local musician, who had expressed utter disbelief of the idiotic little nigger's musical powers, insisted upon Tom's playing after him a fantasia of his—the musician's—own composing. The boy had been severely tested in the course of the long evening's entertainment, then completed, and was looking very dull and weary. Mr. Oliver refused to accede to the request ; it would, he said, be cruelty. The musician sneeringly remarked that Mr. Oliver knew as well as he did, that when tried with a piece it was absolutely impossible his "prodigy" could have heard before, Tom would fail. Mr. Oliver then permitted the test to be applied, although several members of the audience protested against it. Tom sat by the musician while he played, his head rolling nervously from side to side, struck the opening cadence, and then, from the first note to the last, gave the *secondo* triumphantly. Springing up, he then proceeded to play the treble with greater force and brilliancy than its composer displayed, yelling with triumphant delight as he struck the last chord, and crying, "Um's got him, massa ! um's got him !" The audience rose in great excitement, and cheered him heartily, Tom's voice rising with the loudest. It was an hour before the poor negro's hysterical agitation was calmed down.

A Subterranean Forest.—During the progress of some excavations in 1882 on Lord Normanton's estate, near Crowland, Peterborough, the workmen exposed about three acres of a subterranean forest ten feet below the surface. Some of the trees are in an admirable state of preservation, and one gigantic oak measures eighteen yards in length. The trees are in such a condition that oak can be distinguished from elm, while a kind of fir-tree seems to be most abundant, the wood of which is so hard that the trees can be drawn out of the clay in their entirety. The surrounding clay contains large quantities of the remains of lower animal life.

THE "FOSSIL TREES" OF BERMUDA.

In many parts of Bermuda, and especially in Boaz Island, may be seen, close to the roadside, and occasionally in the roadway itself, dark bodies of a peculiar form. Until quite recently these were pointed out by the inhabitants without hesitation as the well-known "fossil trees" of the islands: the roots, in fact, of trees which were overwhelmed with the "blown" sand, and whose vegetable matter had, in process of time, been replaced by carbonate of lime. In Fig. 1 annexed (taken from "The Voyage of the *Challenger*") we have a very characteristic specimen. It is about eight inches high, and cylindrical in shape; the walls of the cylinder are rough, with transverse ridges and grooves, which bear a close resemblance to the lines of insertion of *endogenous leaves.* The upper surface forms a shallow depression, surrounded by a raised border about an inch high. The bottom of the basin is level, and pitted, all over with marks like those made by rain on sand. The cylinder terminates a few inches below the level of the surrounding limestone in a rounded boss, and all over this are small projections, resembling the origins of rootlets.

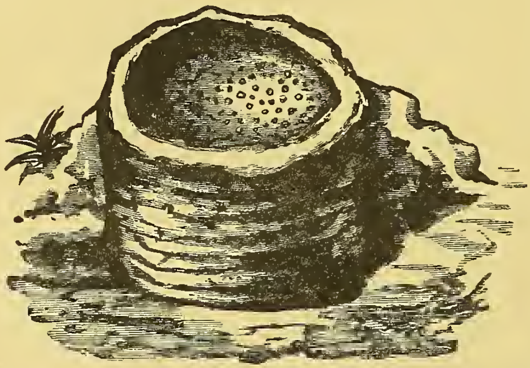
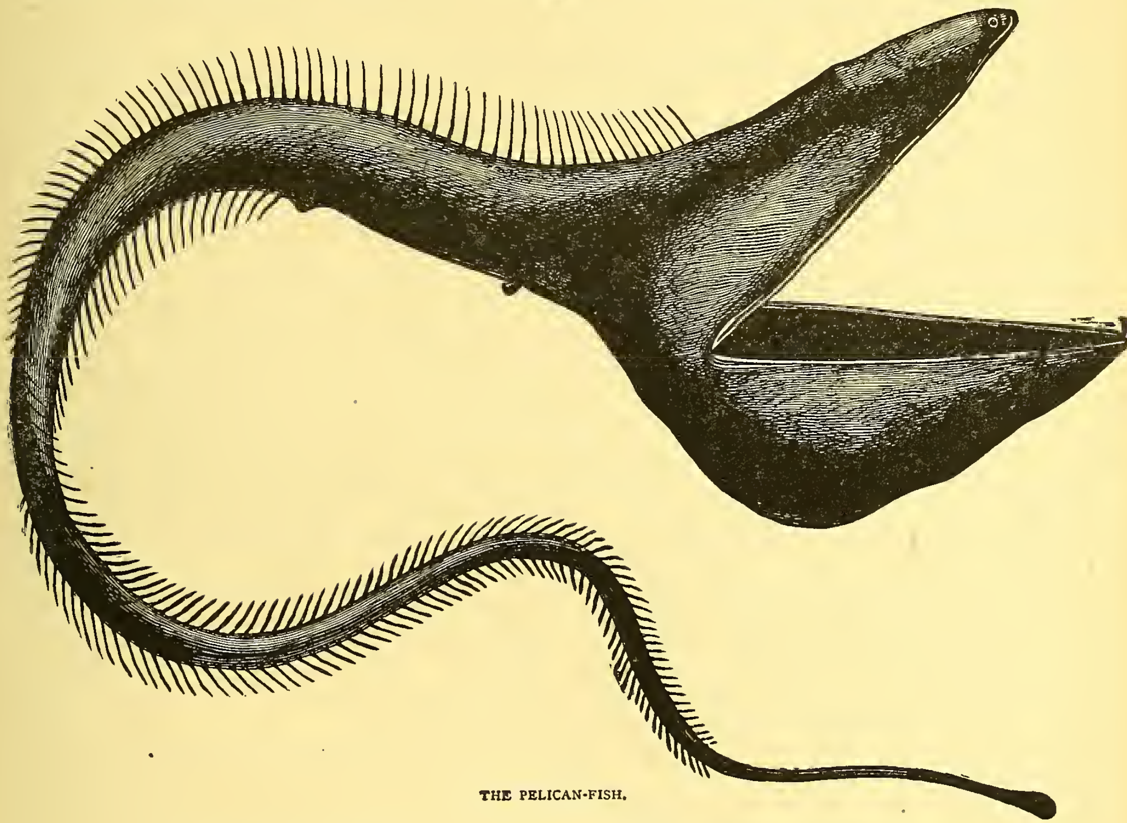


Fig. 1.—"FOSSIL TREE."

Fig. 2.—GROUP OF FORMATIONS.

These details certainly give strength to the popular explanation of these very curious and unique objects; but there are reasons which seem fatal to their vegetable origin. In several places groups resembling Fig. 2 (also from "The Voyage of the *Challenger*") can be seen. In these will be noticed the raised border, the horizontal lines on the outer walls, the pittings on the upper surface, which have already been mentioned; yet their shape and arrangement clearly preclude the possibility of their ever having formed the roots of trees. Sir Wyville Thomson offers the following as the most probable explanation of their origin.

In limestone caves, when once a thread of water has found its way through the roof, single drops, charged with carbonate of lime, will fall from a stalactite for ages on one particular spot on the floor. The splashing water causes a ring-like crust of lime to be formed, and this ring determines the position of the wall bounding the little lake, or pool of water. Gradually the floor of the cave becomes elevated by the accumulation of sand and *travertine*, and, of course, successive layers of stalagmite cause the walls and floor of the cup to rise also. Moreover, the water percolating through the walls of this cup into the softer limestone of the floor hardens the floor; the latter, in fact, becomes lined, and finally blocked with stalagmite. These tubes and threads of stalagmite form the "rootlets" already noticed. The curious patterns often found in these groups are due to the drops falling from closely associated stalactites. Now, in Bermuda, denudation of the surface has been very rapid and extensive, even within recent years. Wherever in these islands is found a flat exposed surface of rock, there are traces of its having once formed the floor of a cave. The wearing agencies of climate, wind, rain, sun, have in the lapse of time done their work on the porous "blown" limestone, and the walls and roofs of the caves have disappeared, the disintegration, however, being temporarily checked by the exceptional hardness of the floors, which, as above explained, have been cemented into a nearly homogeneous mass by stalagmite matter. And then, as the wasting action of the weather proceeds, the old concretionary structures are once more exposed; the parts specially hardened by the localised infiltration of lime resist the longest, and project, as we have seen, above the general surface of the rock. Still, it must be confessed that when one is looking at a number of these singular objects grouped close together by the roadside, it is hard to resist the conviction that the popular account is the true one, and not to believe that long ago, when there was no one to see them, noble trees, either palms or cedars, of which these are the fossil remnants, waved in the passing breeze.



THE PELICAN-FISH.

THE PELICAN-FISH.

THERE is no class of animals in which the weird and strange are better represented than the group of fishes. One of the most singular species of these animals has lately been procured by a French expedition, organised for the purpose of investigating the sea-depths. This expedition has been engaged since 1880 in its laborious work, the vessel in which the naturalists prosecute their voyage of discovery being the *Travailleur*. Mr. Milne Edwards, one of the staff on board, has forwarded the details of structure and habit which characterise the very curious fish depicted in the accompanying plate. The weird aspect of the animal speaks for itself. It was obtained from a depth of 7,080 feet, near the Canary Islands. The bed of the ocean whence the fish was obtained is covered by a chalky ooze, which, as elsewhere, is found under the microscope to be composed of the minute shells of *Globigerinæ*, and other species of chalk-animalcules or *Foraminifera*, as they are technically named. It was the same chalky ooze which, existing in the beds of past oceans, and elevated to the position of rocks, formed the Chalk we familiarly see to-day in the south-east coast of England and elsewhere. The fish taken from its deep abode has received the name of *Eurypharynx pelecanoïdes.* The first of these names applies to the very largely developed mouth and "pharynx," the latter cavity being simply the hinder part of the mouth itself. The term *pelecanoïdes* applies, as the name itself suggests, to the likeness which exists between the pelican's "gular pouch" and the mouth of this fish. In the pelican, as every one knows, the skin and tissues forming the floor of the mouth are greatly expanded, and form a large pouch, in which the bird places the fishes it procures. In the fish, the resemblance to the bird is well seen; and the name which has been applied to indicate its species has, therefore, the merit of at least being suggestive and exact. For popular purposes we may, therefore, style the animal the "Pelican-fish."

The fish described by the French naturalists belongs to a type differing materially from that of any other known fishes. It is placed in classification near the group of which the cod and haddock are familiar representatives; but it is needless to add that in its conformation and structure it differs widely from these fishes. A fish known as the *Gymnelis*, which inhabits the northern seas, and which possesses a long body of slender make, is said to be the nearest ally to the pelican-mouthed specimen of Milne Edwards. The mouth of the fish, as may be seen from the illustration, is quite unarmed save for two very small teeth which are set in the part of the lower jaw. The pelican-like fold of skin forming the floor of the mouth is of very distensible and elastic nature. In all probability it serves to store the food on which the fish subsists.

But where mere suggestion fails in natural history, analogy often appears before us as a useful guide to a knowledge of facts. M. Milne Edwards remarks that possibly the "bag" of the fish may serve some digestive process in addition to its being used for the storage of food; and the very small size of the stomach renders this view in some degree feasible. Furthermore, there is a deep-sea fish known as *Chiasmodus niger*, which inhabits the North Atlantic Ocean, at great depths. This fish also belongs to the cod-tribe, and is, therefore, related to the "pelican-fish" of our illustration. In *Chiasmodus*, which is found at depths of 9,000 feet, the stomach and abdomen can be distended to a literally immense degree. A large fish has been found to be enclosed in its stomach, having been swallowed bodily by the *Chiasmodus*. What the extremely distensible throat and stomach are to this latter fish, it may be believed the throat or floor of the mouth is to the "pelican-fish," which may thus, in the large size of its "pouch," find compensation for the evidently limited size of the internal organs of its frame.

The fins of the pelican-fish are very feeble, and exhibit a rudimentary development. The back fin is a mere series of "fin-rays," without any connecting fin or membrane. The "breast-fins," seen in the illustration, beneath the eye, are likewise greatly reduced in size. These facts seem to show that the "pelican-fish" is not an animal of lively habits, and that it probably rests on the floor of the ocean, or moves in serpent-like fashion over the sea-bed where it procures its food. The fin of the lower surface or belly, like that of the back, is represented by a series of free and detached rays. The tail itself is finely drawn out into a mere thread-like extension of the body; and the tail-fin appears as a very small flattened disc at the tip of the thread-like extremity.

It is interesting to observe how, in living nature, modification and alteration of the type of an animal or plant are well-nigh universal, and affect, as a rule, the entire organism. It would be surprising, for instance, if in the case of the "pelican-fish" we found the gills or organs of breathing naturally developed, as in ordinary fishes. When we are presented, as in the case before us, with a creature whose whole body has evidently undergone great modification and change, we expect to discover that each system of organs and parts has participated in the work of change. Nor are we disappointed in our expectations. For example, the fins are abnormal in their structure; the mouth and digestive organs are altered; the teeth are of unusual kind; and we discover that the gills share in the general alteration to which the fish has been subjected. These latter organs, in ordinary fishes, are comb-like in form, as any one may realise who looks at the red gills of a cod or herring. In the "pelican-fish" the gills have become much reduced and modified. There are six internal branchial slits or openings through which it is believed the water gains access to the gills from the mouth. Externally, there are a pair of apertures which seem to exist in place of the gill-flap or gill-cover seen in ordinary fishes. By these latter openings the water, after being used in breathing, escapes from the gills. The colour of the fish, it may be added, is a deep black hue. Other deep-sea fishes (*e.g.*, *Chiasmodus*) exhibit the same colour. The existence of a well-developed colour in animals living so far from the light in the sea-depths, constitutes a problem, the solution of which has not yet been successfully attempted by zoologists.

The "pelican-fish" is not without company in respect of the slender conformation of its body. There exist certain fishes, known as *Band-fishes* (*Cepolidæ*), in which the body is very greatly compressed from side to side, thus reducing the thickness of the fish to that of a mere line. More notable are the *Ribbon-fishes*, some species of which may attain a length of 20 feet. These fishes are also of very thin conformation, and as their bodies are of a tolerably uniform depth throughout, they have been most appropriately named. It would appear that these fishes, like the "pelican-fish," are of deep-sea habits. When they have been suddenly brought to the surface of the water the gases contained in their bodies, released from the pressure of the water, loosen their tissues, and it is with great difficulty that they can be procured as entire specimens. A long "ribbon-fish" swimming near the surface, or seen from a distance, might give rise to the idea of a "sea-serpent," especially if viewed by persons unacquainted with zoology, and who were unfamiliar with the peculiar form of these animals. One feature of the ribbon-fishes, which relates them to the "pelican-fish," consists in the literally marvellous development which many of their fins exhibit. The fins are often provided with curious "lappet-like" expansions, and many of their rays may be several times larger than the body itself. Such delicate appendages seem to show that, in their natural state, these creatures are intended to live in the quietude and silence of the abysses of sea. The rougher life near the surface, as has been remarked, would at once be fatal to the delicacy of the appendages which form such characteristic features of these fishes.

FLAGELLATION.

A BELIEF prevailed anciently amongst priests and physicians in the efficacy of flagellation as a remedy for moral and physical ills, and was acted upon to an extent, and in a manner, which we now regard as wonderfully strange. Doctors believed that it cured cutaneous eruptions, gave the blood a wholesome and beneficial stimulus, aided digestion, promoted absorption, and increased muscular energy. Galen recommended it to give *embonpoint* to the lean. Priests regarded it as a mortification of human pride, and a species of religious discipline of the body peculiarly acceptable in the eye of Heaven. Amongst the monastic orders of both sexes, flagellation was a regular form of discipline and penance, nudity being insisted upon in either case. The monks of Fonte Avellana determined that one hundred stripes, inflicted while a psalm was said or sung, if repeated thirty times, should be considered as an equivalent for one year of purgatory after death; or the whole of the Psalter, with fifteen thousand stripes, as equal to five years' suffering in the flames of purgatory. These monks touched neither wine nor oil, and for five days in every week lived on bread and water only, flogging each other after service every day. One of their number, now known as St. Dominic the Cuirassier, because he always wore an iron cuirass by way of penance for his parents' sin in presenting a garment of rich fur to the bishop who ordained him, is said to have also lashed himself every day with the rest, but with increased severity, singing ten psalters, and inflicting thirty thousand lashes every day, supplementing this liberal supply during Lent by administering thirty-four thousand five hundred lashes while repeating two psalters and a half. St. Pietro Damiano—who was also a cardinal—records the saint's Lenten share of stripes as sixty millions! Arithmeticians have pointed out that, administered at the rate of two blows a second all through the four-and-twenty hours, the sum-total could only be one hundred and seventy-two thousand eight hundred, so that the saint's miraculous energy and endurance in exceeding that number cannot fail to be regarded as wonderful indeed.

During the reign of Casimir III., called the Great, last male of the House of Piast, the Flagellants arose, a set of fanatics who grew rapidly in number, and came into Poland from Hungary. The first leader of this extraordinary sect was a hermit named Rainer. His followers were of all ages, and both sexes. They marched from place to place two by two, naked to the waist, and with crosses on their lower garments, their shoulders and backs frightfully disfigured with wounds and sores caused by the merciless whippings they gave each other. Twice in each day, and once in the night, did they inflict their terrible penance, crying aloud for mercy to God all the while, sometimes in the churches, sometimes in the public cemeteries. When the flagellation was concluded they would suddenly throw themselves down, however great the hurt they received from stone or flints, or however muddy the spot on which they stood. Then one of their lay preachers would pass from one prostrate figure to another, saying, "God has forgiven thee thy sins." The Flagellants regarded thirty days of such penance as full atonement for sin. They dispensed, therefore, with the sacraments, regarding them as abrogated. They preached "without shedding of blood there can be no remission;" and their success in making proselytes was most extraordinary. Hungary, Poland, Germany, Italy, France, and England were soon overrun by these strange enthusiasts. They disappeared after a time, but reappeared in the 14th century. In the 15th century their leader was Conrad Schmidt, who with several of his followers were burnt by the German Inquisitors, about 1414. It appears that they still exist in some parts of Italy, where efforts are again being made for their suppression.

Amongst the monastic orders flagellation was of two kinds; the upper, inflicted on the shoulders, and the lower; the latter being chiefly adopted by females to avoid the twisting thongs seriously injuring the sensitive bosom.

Brantome speaks of flagellation as a common form of punishment inflicted by ladies of rank, and tells how one of the Queen's Maids of Honour, Mademoiselle de Limeuil, was so castigated for having written a pasquinade, as were also all the young ladies who had been privy to its composition. The minions of Henry III. of France appeared in white robes, to be stripped and whipped in procession for the mere gratification of their royal master. Ladies sometimes combined to inflict flagellation upon men who had given them offence. In this way Clopmel the poet was about to be punished for having written some lines libelling their sex, when by some witty retort he saved his skin, and was forgiven by the angry beauties, who, with rods in their hands, and arms uplifted, were on the eve of inflicting a terrible castigation. Medical men were at one time of opinion that flagellation injured the eye-sight, in consequence of which opinion its modified form of birching became most common.

WIND-CARRIAGES AND ICE-YACHTS.

THE ingenuity of man, long before it culminated in the invention of the steam-engine, was for many centuries busy with schemes for doing by automatic and mechanical means the work usually done by hand. If we look back to the records of natural philosophy as it was understood only a century back, we shall find plenty of wonderful contrivances designed as labour-savers—many of them dealing with that old belief in perpetual motion which the modern doctrine of conservation of energy has taught us to be impossible.

Fig. 1.—OLD WIND-CARRIAGE.

We can easily understand how the terrific power exerted by wind and water in storm and flood would strike any man, even in a primitive state of existence, with the possibility of turning that power to some practical account. But the backward state of the arts of construction would for many centuries have prevented him putting his crude ideas to the test of experiment. This would account for the comparatively late period at which such natural forces began to be recognised as valuable servants, although they were sometimes such cruel masters. Windmills for grinding corn were brought from Greece to Rome about 150 B.C.; later on, the Romans used water-power for grinding their grain. We learn that when the city was besieged, A.D. 555, the enemy cut the fourteen aqueducts which carried water into Rome, and therefore stopped the mills, so that the people were in great straits for food. In England, windmills became common about the twelfth century, if we may judge from the many references concerning them which appear in the records of the time.

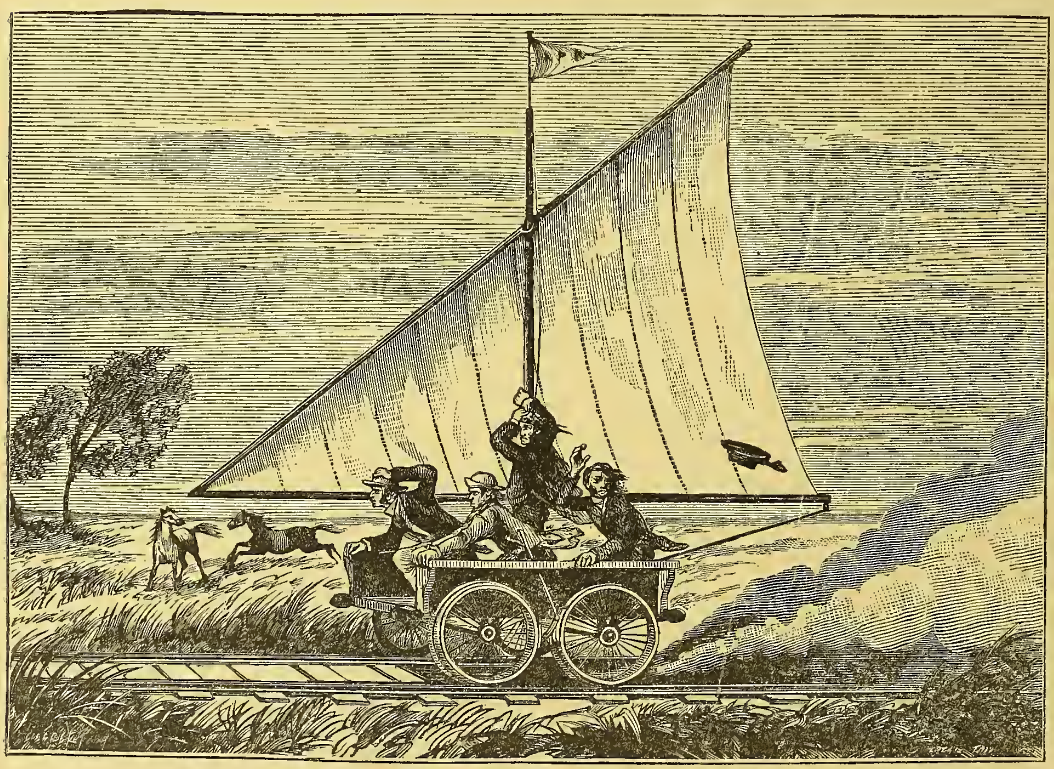
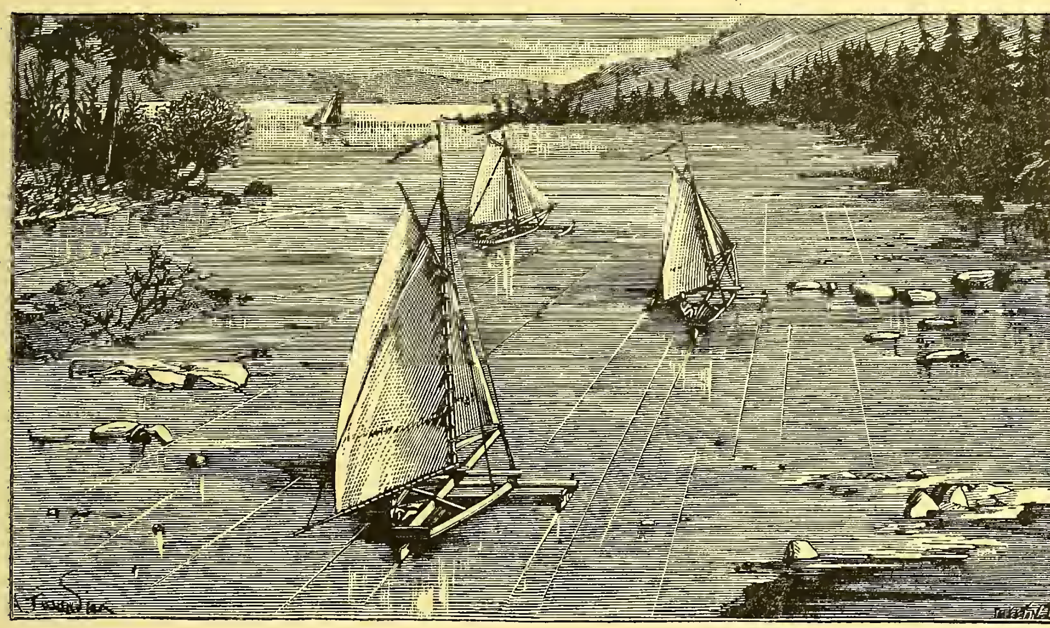


Fig. 2.—WIND-CARRIAGE ON THE KANSAS-PACIFIC RAILWAY.

At a far earlier date the force of the wind was employed for boats—indeed, the floating tree-trunk, which probably gave man his first notion of a boat, might, without much stretch of the imagination, be crowned with a bough which pictured to him the advantages of a sail. But not only on water have such sails been in use in remote times, but they have been employed in propelling carriages on land. The Chinese have for centuries used a kind of barrow drawn by a donkey, and furnished with a sail which can be raised aloft when weather and direction of wind permit. Another form of wind-car is described in old books upon Physics as containing sails like a windmill, which turn round and act by gearing upon the axle of the wheels.



CANADIAN ICE-YACHTS.

Kites have also been employed as a means of propulsion, and have figured in other useful ways on many occasions. We need hardly refer to the kite with which Franklin drew lightning from the clouds, and thus identified it with electricity. On many occasions kites have served to carry cords over high steeples and buildings when repairs to weathercocks have become necessary. A still more notable service rendered by a kite was when the first wire of the Niagara Suspension Bridge was thus carried across the rapids by the wind. But kite-carriages present, perhaps, the most curious adaptation of wind-power to which we could point. In 1827 a carriage, invented by Mr. Pocock, with a couple of kites as its trusty steeds, travelled from London to Bristol. The time which this extraordinary journey occupied is not stated, but the projector has left some records as to the power expended, and so on, which, whilst not to be regarded as strictly accurate, are interesting as concerning a means of locomotion now quite forgotten. Pocock estimates the drawing-power of a twelve-foot kite in a moderate breeze to be equal in strength to one man. In a high wind that power is about doubled. Two kites of twelve and fifteen feet respectively will ensure a speed of twenty miles per hour, and can be burdened with a carriage containing four or five passengers. This mode of locomotion, however, has lately become practically impossible in England, owing to the intersection of the whole country by telegraph-wires, which of course cross the kite-lines, and so bar farther progress.

The venerable Bishop Wilkins, in his book on Mathematical Magic, dated 1648, gives some account of wind-carriages as then known. He tells us that they were used in China, Spain, and other countries, but principally in Holland, in which latter country they frequently surpassed in speed that of a ship. They carried from six to ten passengers with very little trouble to the man at the helm, and represented by far the quickest mode of locomotion then known. Figure 1 is a representation of one of these Dutch sailing-carriages, copied from an engraving of the seventeenth century.

It is possible that these wind-carriages would have been greatly improved upon, had not the introduction of railways taught us that a quicker and far less fickle servant can be found in steam.

But, strange to say, the railway itself has led to the revival of these old wind-carriages for special uses. Our second illustration is from a photograph of a wind-carriage, or rather truck, which is now in actual use on the Kansas Pacific Railway. It is used as a means to convey workmen and their tools to places far from the haunts of man, where the permanent way requires repair, or where telegraph-posts or wires have become deranged. This little truck is six feet long, and has four wheels, each thirty inches in diameter. Its mast carries a sail fifteen feet long, which can be readily hauled down when required. Its speed increases from thirty miles per hour in a moderate breeze to forty miles when the wind is fresh. It occasionally travels at a greater speed even than this if the wind be favourable—that is, right across the track—and if the road is fairly straight and level. The car has the merit of cheap construction, and is of such a weight that its occupants can lift it bodily from the rails if a train be at hand. It serves a useful purpose on the broad prairies of Western America, but would be clearly out of place on the railroads familiar to British eyes.

For another curious instance of modern propulsion by the power of the wind, we must look to our Canadian friends. During their long and rigorous winter, when the ice is for weeks as hard and safe as a stone pavement, the ordinary pastime of skating is diversified by skating of a far swifter and more hazardous nature. In what is known as the ice-yachts, we find a framework roughly representing the outline of a boat, supported upon two elongated steel runners or skate-blades. A third blade behind answers the purpose of a rudder. This mode of travelling is very popular in many parts of Canada, and its more enthusiastic votaries affirm that they can rival the speed of an express train. By reference to the illustration it will be seen that the mast is placed in a forward position in the framework, but its rigging is so simple, and is under such ready control, that the sails can be lowered at a few seconds' notice. The Americans, we understand, are more partial to ice-yachts with only one sail; with such craft they think nothing of moving along with the velocity of the strongest wind. We may also mention that at the Naval Exhibition at the South Kensington Museum there are, or were, models of some Finland ice-yachts propelled by two sails

FEIGNED DISEASES

A VERY curious and interesting chapter in human history is that which deals with persons who, to quote Shakespeare, "turn diseases to commodity," simulating sickness either to escape punishment, appeal to the charitable, or avoid disagreeable duties. Some wonderful instances of this species of imposture are on record. Cases of such deception have been so cleverly contrived as to defeat detection, and that so frequently, that Foderé believed it to be as difficult for a physician to detect a feigned as to cure a real disease. They are most common amongst criminals, and in the army and navy, especially amongst recruits, some of whom repeatedly received the money gratuity given on enlistment, and were as often discharged on the ground of their being afflicted with diseases which were at last discovered to be simulated.

Dr. Hennen says, "Some soldiers appear to experience an unaccountable gratification in deceiving their officers, comrades, and the surgeon." Marshall believed that in some instances these cases really indicated insanity, and mentions the case of a man who divided the *tendo Achillis* with a razor, and did all he could to prevent its re-union, although he was a good soldier and bore an excellent character. He had been in the service twenty-six years, and might have claimed both his discharge and his pension whenever he pleased!

"The Cyclopædia of Practical Medicine" states that many cases exist to show beyond all doubt that diseases have been simulated where no motive could be discovered for their adoption, further stating that in such cases they were the symptoms of what is called "moral insanity." Overweening conceit and a consequent desire to attract attention has in some cases been the attributed cause; but by many this also is recorded as characteristic of insanity. Both acute and chronic diseases are so imitated.

Dr. Gavin, in a work on the subject published in 1843, mentions one case which for four years baffled detection, and defied the investigative efforts and experiments of the most scientific men in France, Germany, Italy, and Switzerland. This was the case of a man named Victor, who pretended to be deaf and dumb, and to have been born so. It was soon believed that he could both hear and speak, although every test adopted proved a complete failure. He was put to the most trying proofs. A young and beautiful woman made love to him. He affected not to hear. She offered him her hand. He appeared to be quite unconscious of her goodness. In the prison at Rochelle he was never left alone, and a turnkey slept with him every night. He was suddenly awakened from his sleep and spoken to, but beyond making a plaintive noise, he uttered no articulate sounds, and even when dreaming only guttural sounds were heard. He never spoke. He mingled with a hundred prisoners who were all intent upon making him speak or hear, in vain. He expressed all his wishes in writing; and having so stated that he was an élève of the Abbé Sicard, was by him exposed, for the Abbé pointed out that in correspondence with him he wrote words as he heard them pronounced, not as they were spelled or seen. The following extracts will serve as a specimen of his writing, and illustrate the ingenious manner of his detection :—

"*Je jur de vandieux; ma mer et nē en nantriche; quhon duit* (pour *conduit*) *essepoise* (pour *espoir*): *torre* (pour *tort*) ; *ru S. Honoret; jai tas present* (pour *j'étais présent*); *jean porte en core les marque* (pour *j'en porte encore les marques*).

It will be seen that in his letter Victor uses *q* instead of *c*; and from this the Abbé knew that he had acquired by hearing the knowledge that the sound of these gutturals was similar.

Dr. Cheyne mentions the case of a soldier pretending to be dumb, who was shot in the ear by an awkward recruit, and restrained himself from uttering a cry of pain. This man remained in the army five years, and was always supposed to be dumb, although directly after his discharge he began to talk.

A seaman on board the *Utile* frigate pretended to be deaf or dumb, and the surgeon, confident in his not being really so, determined to terrify him into speaking. He began elaborate preparations for an operation upon the throat, which he spoke of as one which was excessively painful. The man however, displayed no signs of fear, and when the surgeon applied a lighted candle suddenly to his fingers, without the patient's knowledge of his intention, the man still preserved silence. He complained to the Admiralty, and the surgeon was dismissed the service for cruelty. Yet directly he found the purpose he had was not served, this martyr of untruth gave in and confessed himself an impostor.

Dr. Gavin speaks of madness as one of many diseases feigned for fraudulent purposes; frequently as a means for extorting charity, by working on fear and escaping from a prison into a lunatic asylum ; but says it is seldom simulated with success. "We are," he says, "in more danger of supposing insanity simulated when real, than of supposing that disease to be real which is only pretended." Raving madness is, we are told, more frequently because more easily imitated than monomaniacal. "The mental and physical peculiarities of partial mania," says Dr. Gavin, "are of a kind that do not obtrude themselves on the observation, and instead of loudly proclaiming his crazed condition, and soliciting the attention of the beholder, some investigation is required in order to discover them. This, however, is contrary to the purpose of the simulator, which requires an immediate and powerful impression to be produced on the minds of his supervisors." Marc states that the real monomaniac is obstinately prejudiced in favour of his opinions, an attack upon which excites his anger, while contradiction, if skilfully managed, has no such effect upon the pretender.

Amongst the diseases most commonly feigned is inflammation of the eyes, an appearance of which is produced by the insertion of stimulants. The dilation of the pupil which generally characterises amaurosis can be produced by the extract of belladonna, or of hyoscyamus applied to the skin round the eye. In imitating diseases of the eye actual disease is frequently produced.

Mr. Marshall, in his well-known work "Hints to Young Medical Officers," speaks of a state resembling fever, produced by swallowing small quantities of tobacco. Mr. Hutchinson met with a case of affected disease, in which he found an apparently unhealthy tongue owed its appearance to a coating of common brown soap ; and a case at Fort Pitt, where the tongue was made brown, dry, and hard, in some way which was shown to be artificial only by too strongly marked a line of demarcation between the affected parts and the parts not coated, which were perfectly healthy.

Cases are on record in which men have sat or walked in the most painful positions for weeks and months, and others in which sores artificially produced have been regularly irritated so long, as to end in the limbs operated upon being of necessity amputated.

Chronic disease of the liver is often simulated, and Mr. Marshall mentions the case of a soldier who had grown weary of the army, assuming this complaint, who pointed out his left side as the locality of his liver. The medical officer affecting to believe him, and to regard the case as a serious one, put him into an empty ward, where in loneliness and misery he was kept on a very reduced diet, and treated with *antim. tart.* and *mistura diabolica* (a mixture of salts, infusion of tobacco, assafœtida, &c.), exhibited in very small doses with sufficient frequency to keep the horrible taste always in the mouth. This martyrdom the unhappy wretch endured for a month, and then recovered with wonderful rapidity.

At another time a troublesome soldier went into hospital stating that, in consequence of his loins having been hurt, he had lost the use of his lower limbs. From the first it was believed that he was an impostor, but he persisted in his plea of being unable to stand or walk, so that eventually, to save further trouble, he was discharged. On the day his discharge was made out he crawled into the office on crutches very slowly and laboriously, apparently with great pain and difficulty. When the document was given him he respectfully asked one of the officers present to read it to him. This done he threw down his crutches, and darted off, overturning a couple of men who were in his way, and leaping over a car with a water-cask on it, as he emerged from the door.

In 1821 or 1822 palpitation of the heart was epidemic among the men of the Marine Artillery. This was traced to the use of the powder of white hellebore, which not only increased the action of the heart, but occasioned distressing headache, nausea, vomiting, and sometimes violent purging. This had been introduced by a man who had been a veterinary surgeon. He furnished doses to the men at threepence each, or told them what it was he gave them for three shillings and sixpence.

In the police-force such cases also sometimes occur, and the London street beggars frequently produce appearances of the most terrible and repulsive diseases, and often actual diseases entailing a condition of constant suffering, to avoid work and to provoke the pity of charitable but credulous passers-by.

STICK-INSECTS.

AMONGST the services for which Natural History has to thank Mr. Darwin, altogether apart from his main theory, one of the greatest is his having called attention to the importance of certain apparently minor facts, and thus led to a great number of most interesting observations and generalisations. Questions which would probably never have risen to any prominence but for the light suddenly thrown on them by the Darwinian hypothesis, were all at once invested with an interest which no one had suspected to belong to them; and, whether the results of their investigation were favourable or not to the hypothesis, science undoubtedly was a great gainer. Many new facts were discovered, isolated well-known facts were shown to be connected with others, and through these with each other, and the purpose of many previously inexplicable phenomena became more or less clearly visible.

Among these were the curious facts, many of them previously known, to which the term "mimicry" has since been applied. In this sense the word may be said to mean the simulation by an animal or plant, for some purpose connected with its own welfare, of the characters presented by some other animals or plants, or by surrounding objects generally, a view of the matter which was no doubt previously taken, but which has gained enormously both in breadth and precision since the first appearance of Mr. Darwin's works. In a host of cases it is found that otherwise defenceless creatures show the closest and most deceptive resemblance to others which are well armed, or endowed with some property rendering them so disagreeable to the animals which would naturally prey upon them, that the latter, after one or two experiments during the inexperience of youth, abstain from attacking them for the rest of their lives; and this immunity is observed to be extended to the mimics. In other instances we find that parasitic insects acquire the most singular resemblance to the species on which they are parasitic, an arrangement the utility of which to the parasites it is not difficult to see.

The examples that we wish to bring under the reader's notice at present belong to another series of cases, in which the mimicry consists in a disguising or protective resemblance in the appearance of the mimic either to the general character of its surroundings or to some special features of them. One of the best general cases in this class is presented by the colouring of the animals inhabiting the arid deserts of various parts of the world (such as most of the birds, the rat-like jerboas, the lizards, and even the formidable lion) which, as is well known, generally show brownish or yellowish tints, assimilating them so closely to the colour of the surrounding sand and rock that it is with difficulty they can be discerned. Most interesting instances of a more special nature are presented by the tiger, an inhabitant of the jungles, whose skin represents the effect of strong sunlight barred by the shadows of canes and bamboos; and the leopard and jaguar, which habitually reside in trees, and whose beautifully-spotted coats reproduce most remarkably the flecked sunlight coming through the foliage from above. In this country we have in great abundance examples of this protective resemblance to surrounding objects—beetles resembling little clods of earth or the droppings of animals; moths which reproduce in the most illusive manner the colour and texture of the bark of trees, or of the lichens which grow upon them; others closely resembling fresh or dead leaves; in fact, we may find a host of more or less striking instances in which our native animals are assimilated so closely to their surroundings as easily to elude observation.

Amongst others may be instanced the caterpillars of some of the moths, which are commonly known to collectors as Geometers or Loopers, from the peculiar mode of locomotion adopted by them. These larvæ have, on the three segments immediately behind the head, the usual three pairs of jointed legs, but then the whole of the succeeding segments possess no organs of locomotion until we come to quite the hinder end of the body, where the last two segments bear each a single pair of fleshy clasping organs (prolegs). By this arrangement of the limbs the caterpillar is made to walk by a series of steps; the body being stretched out to its full length, the true legs adhere; then the hinder extremity is brought close up behind them, the body being bent into a loop; the prolegs then adhere, and the body is again stretched out; so that as the insect advances it seems to be engaged in measuring the ground it passes over. Some of these caterpillars, which show a remarkable likeness in the colour and texture of the skin to the

Keraocrana papuana, A STICK-INSECT FROM NEW GUINEA (*Natural size*).

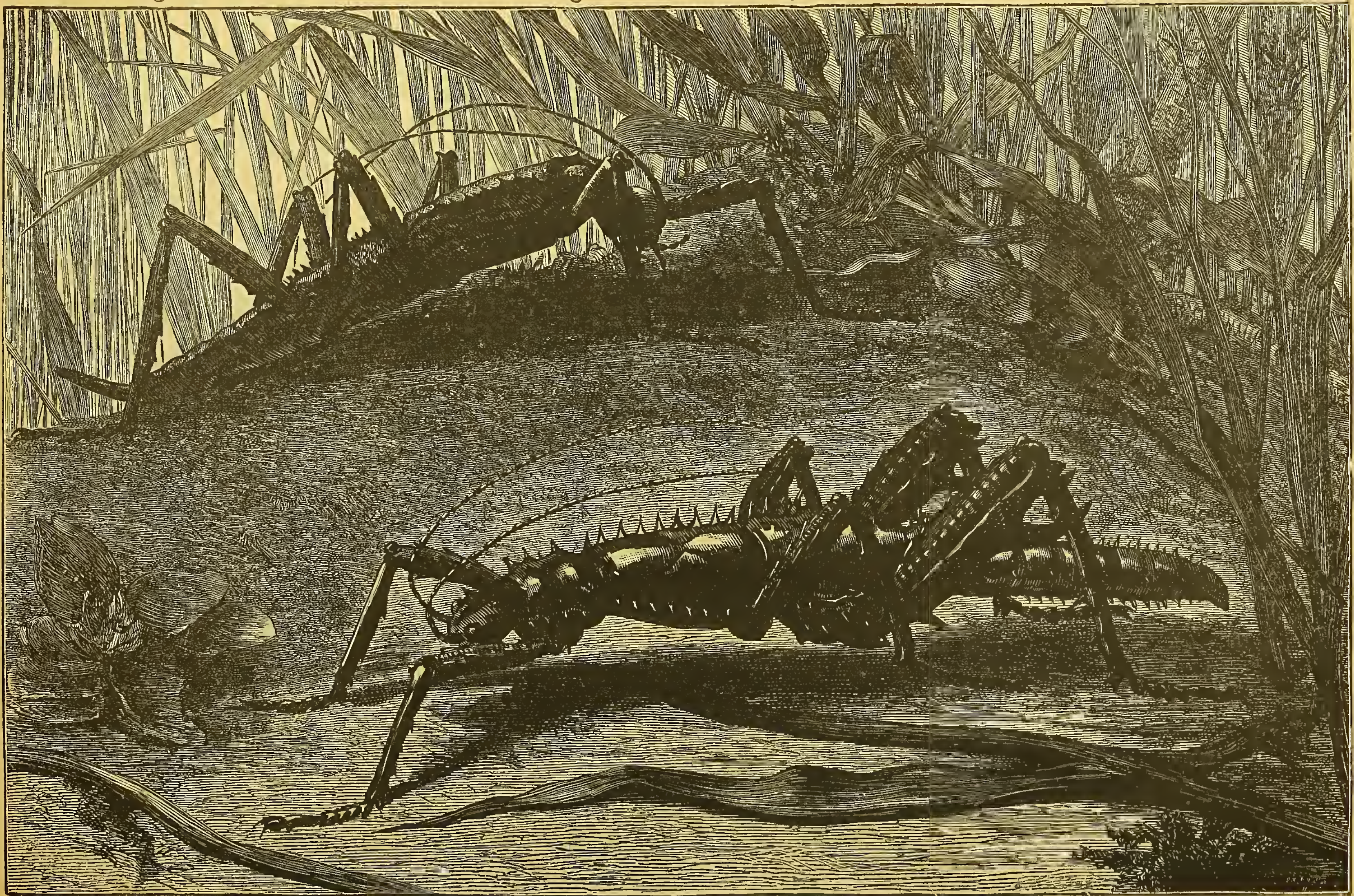
bark of the twigs of the trees and shrubs on which they live, make use of the strong clasping-powers of their prolegs to mimic very strikingly those parts of the plant. After stripping the real twigs of all their foliage, they fix themselves firmly by these hinder claspers to the main branch, and then extend their bodies stiffly at about the same angle as the real twigs, from which it is often impossible to distinguish them without very close examination. To a certain extent, therefore, these caterpillars may be denominated "stick-insects;" but the curious creatures which are more properly known under that name belong to a very different group of the class, and are not mere isolated members of a family including many species which have no likeness to sticks at any period of their existence. These true stick-insects form nearly the whole of a family of their own.

Of these remarkable insects about 600 species have been described, chiefly from the tropical and sub-tropical regions of both hemispheres, although a few occur in the warm temperate zones. Two are found in southern Europe; they are especially numerous in Australia; and range in great variety through the Eastern Archipelago, and in the innumerable islands which stud the surface of the Pacific Ocean, extending southwards as far as New Zealand. According to Mr. Bates, the species are not abundant anywhere; but this scarcity may be only apparent, and due in part to their activity being chiefly nocturnal, and to the difficulty of discovering them when at rest during the day, from their resemblance to the parts of plants to which they cling. Some species, at any rate, occur in sufficient numbers to become formidable, as in the case of one inhabiting many of the South Sea islands, which attacks the cocoa-nut trees, and often does great damage to them; and other species are mentioned by travellers as making their appearance in great numbers.

One of our figures, which represents a remarkable species from New Guinea, noticed by M. Kunckel d'Herculais under the exceedingly uncouth name of *Keraocrana papuana*, will serve to give a general idea of the structure of these curious creatures, which belong to the order Orthoptera, a group the members of which undergo no metamorphosis, beyond the acquisition of wings in the last stage of their existence by most, but not by all, of them. Hence, the young larvæ when just hatched present so close a resemblance to their parents, that there is no difficulty in judging of their relationship; and, in the case of the stick-insects, the larvæ are often more stick-like than the perfect insects.

Occasionally, however, these creatures would seem at the first glance to depart more or less from the strictly stick-like form, although, probably, could we see them "at home," even these would be found to assimilate admirably with their surroundings. As an example of this apparent departure from the ordinary character of the group, we have figured a most remarkable species from the Salomon Islands, in which the edges of the different regions of the body, and of the joints of the legs, are armed with numerous spines, which are particularly strongly developed in the male (shown in the foremost figure). This insect belongs to a peculiar spiny genus (*Eurycantha*), species of which occur in several of the Eastern islands and in Australia, where they are described by the French missionary, Père Montrouzier, as living concealed during the day among the parasitic plants which cover the trunks of old trees. The male, as will be seen from the figure, has the hinder thighs very much thickened, and armed with very powerful spines; according to Père Montrouzier these spines are not only employed by the insects for the purpose of seizing the female, but also as weapons of offence, as by raising the thighs and then striking downwards and inwards, he is able to inflict rather severe wounds.

Both winged and wingless species vary considerably in the proportions of the body, some being excessively slender in proportion to their length; others thicker, like the *Keraocrana* figured, which may be regarded as of average stature, although still much elongated; and others considerably stouter in their form, as shown in our figures of the spiny species (*Eurycantha calcarata*). In nearly all cases, however, their resemblance in form to branches and twigs of shrubs and trees, or to the stems of herbaceous plants, is very complete, and is further aided by the brown or green colouring which is characteristic of the different species. Mr. Wallace, who says that these insects are very abundant in the Moluccas, describes them as hanging on the shrubs that line the forest paths, and resembling sticks "so exactly in colour, in the small rugosities of the bark, in the knots and small branches, imitated by the joints of the legs, which are either pressed close to the body or stuck out at random, that it is absolutely impossible by the eye alone to distinguish the real dead twigs which fall down from the trees overhead from the living insects. The writer," he adds, "has often looked at them in doubt, and has been obliged to use the sense of touch to determine the point." To add to the illusion, some of the species have some joints of the legs, especially the thighs, dilated into leaf-like organs, while others have leafy excrescences springing from various parts of the body, producing a resemblance to portions of branches upon which lichens or mosses have grown. There can be no doubt, from the testimony of all observers, that their likeness to vegetable productions serves as a protection to these insects, which, although slow in their



Eurycantha armata, A STICK-INSECT FROM THE SALOMON ISLANDS, MALE AND FEMALE (*natural size*).

movements, manage to live on in spite of the insectivorous birds, with which they are a favourite article of food; and Mr. Belt records his having observed numerous ants running over a large stick-insect without attacking it, as they certainly would have done had they not mistaken it for part of the dead branch of a tree.

These singular creatures were known as "spectres" to some of the older naturalists, and the modern name of the family to which they belong, the *Phasmidæ*, is derived from a Greek word having the same signification. To an imaginative mind there *is* something spectral about them; but, except for the damage that some of them may inflict upon cultivated plants, they cannot be regarded as fitted to inspire dread. Their most marked distinctive character consists in the fact that the first segment of the body behind the head is very much shorter than the second (see figure), a peculiarity which does not occur among any of the allied families; and the long fore legs, which are thus brought very near to the head, have their thighs notched or bent at the base, to make room for the head between, and enable them to be brought close together when stretched out in front of the insect, which is their usual position in repose. This peculiar formation also is well shown in the illustration of *Keraocrana*. The first pair of wings, which in most Orthoptera entirely conceal the second pair, are, in the stick-insects, greatly reduced in size, so as generally to cover only a small part of the latter; and these, which are elegant fan-like organs (as shown in the small flying figure), are often beautifully coloured, usually bright pink or yellow, sometimes banded or spotted with black. Along their fore margin, however, these gaily-coloured wings are furnished with a leathery piece of much the same colour as the body of the insect; in repose the wing folds up like a fan and lies snugly beneath this leathery margin, when the creature still presents its stick-like aspect, or looks like a twig with leaves lying closely pressed to its sides.

In stature many of the stick-insects are gigantic, the females especially growing to a larger size than any other insects. Our figures represent two of them of the natural size, and a good many species equally large are known, while some of still greater length have been described. From ten inches to a foot is generally the extreme length assigned to any species, although reports have been received of the occurrence of such insects from fifteen to eighteen inches long. When molested they are said to exude a fœtid yellow fluid, which has been described as causing great pain and sometimes blindness, if brought in contact with the human eye. Notwithstanding this disagreeable quality, however, these insects, as we have seen, are freely consumed by insectivorous birds when the latter can find them,* and there seems every reason to believe that such sluggish and helpless creatures would long since have become extinct but for the protection afforded to them by their remarkable disguise. Even the species which eventually develop wings have the full benefit of this mimicry throughout the greater portion of their existence, and only lose it in part by the acquisition of the dangerous faculty of flight, when they have nothing to care for but the continuance of their race.

DISEASE-GERMS.

THE gravest diseases which affect the human race, and those epidemics that sweep off their victims by the thousand, were formerly regarded as possessing an origin which was beyond the reach of scientific inquiry. By many, indeed, the source of these diseases was esteemed of thoroughly mysterious nature. They were often regarded in ancient times as solely representing the outcome of divine vengeance; an idea which has been happily replaced by that which sees in such visitations the clear results of infringements of the laws of health. But much more has been done than this. To-day science is really on the track of epidemic diseases, and, like a skilful detective, is slowly, but surely, hunting them down. The gain, not only to humanity, but to lower animal life as well, from the investigation of such diseases, is simply incalculable. When we discover the source of the diseases which affect us and which decimate our race we have acquired a touchstone that enables us to proceed a step farther, and, if not actually to exterminate them, at least to modify and limit their now wide range.

It may be stated that one idea has animated the search after the causes of disease, and has proved a beacon-light to investigators. This idea is implied in the belief that the diseases which spread from one person to another, such as the contagious fevers, small pox, scarlet fever, &c., owe their origin and their spread to the fact of their being caused by the growth within the body of minute *living germs*. Of old, it was believed that these diseases were produced by foul air, bad gases, and emanations. To-day we know that these latter are only the conditions or soils amidst which the diseases themselves grow and are propagated. The essence of the diseases is found in the living germs, which spread from one person and place to another person or locality. The disease itself, in

* According to Père Montrouzier a species nearly allied to the spiny one here figured (namely, *Eurycantha horrida*) is a favourite article of food with the natives of Woodlark Island; and another, *Platycrania edulis*, has received its specific name in allusion to a statement made by the old naturalist, Valentinus, that it is eaten by the Malays.

this light, is merely the result of the growth and increase of the germ which produces it. Just as a seed springs up into a special and recognised form of plant, so each fever-germ produces its own and special disease. Scarlet fever breeds scarlet fever; small pox gives origin to small pox alone; typhoid or gastric fever similarly produces typhoid fever; and cholera-poisoning is followed by cholera outbreak. Again, we see in the circumstances under which these diseases flourish or die, another proof of their living origin. There are some fevers which only appear in the tropics; yellow fever is such a disease. Ague has been banished from our land because we have drained our waste lands, and because the ague poison-germs can only flourish in the malarious conditions present in damp places. So, also, a fever has its incubation, its growth and maturity, and finally its decline and death. In all of these features, the fever or disease presents a very striking resemblance to animal and plant growth. The analogies and likenesses of fevers to living growth are therefore of the strongest kind; but these alone would not suffice to prove that disease-germs are really living animals and plants of microscopic kind. The germs themselves must be traced and studied, and it is to the question of these germs and their nature that we must next direct our attention.

There exists a curious disease to which cattle and sheep are especially subject, and which is named *charbon*, or *splenic fever*. It runs a rapid and very fatal course in these animals, and constitutes one of the veritable "plagues" of the agriculturist. It is highly infectious; it passes from one animal to another with ease and rapidity; and, once allowed to gain a footing in a flock, it, as a rule, decimates the herd. Now, so far back as 1850 certain French observers had noted that, in the blood of animals affected with splenic fever, multitudes of rod-like bodies of minute size could be seen on microscopic investigation. At that time the relations or nature of these rods were utterly unsuspected; but, as time passed, it was seen that the constant association of the disease and the rods meant possibly something more, in respect of the cause of the disease, than observers had hitherto suspected. The appearance of these rods amid the corpuscles of the blood is well seen in the right-hand side of Fig. 1; their stages of development being shown in the left-hand half of that illustration. A German physician named Koch set himself to discover the nature of these rod-like bodies. He cultivated them within the humour of the ox's eye, a fluid closely resembling blood in its nature. Watching them carefully, he saw them lengthen, so that in three or four hours the rods increased from ten to twenty times in length. In a few hours more they had formed filaments, or long thread-like bodies (see Fig. 1); which were often bent or twisted as they lay in the field of the microscope. Next, Koch observed little specks or dots to be developed within the substance of the threads. These specks increased in size and distinctness; they also became so numerous, that they filled the substance of each filament. The thread itself then fell to pieces, liberating the dots or specks, which were recognised as the *spores* or germs of the rod-like bodies.

So far the proof appeared to be tolerably complete, that the rod-like bodies were in reality living

Fig. 1.—BACILLUS OF SPLENIC FEVER.

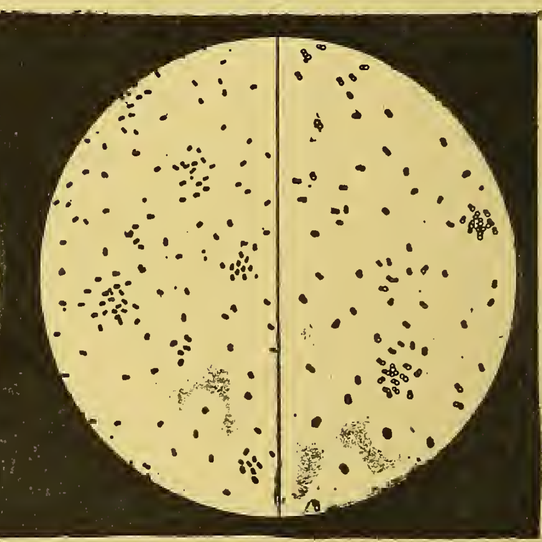


Fig. 2.—GERMS OF CHICKEN CHOLERA.

beings; and it was rendered more probable still that they were miscroscopic forms of lower plant-life. The next point, however, was equally important with the determination of their nature. This point included the demonstration of the relation or connection between the rods and the disease. Koch inoculated mice with the fresh blood of an animal suffering from splenic fever, and found that invariably the mice developed the fever and died. In such a case there was no doubt he had sown, within the body of the mouse, the germs or rods which were present in the blood of the fevered animal. But he did more than this. Seeking to know how it was that this splenic fever was propagated, and how its germs retained their virulence for long periods of time, he dried the blood of an animal infected with the fever. Here, of course, there were only rod-like bodies, and none of their spores or particles. He found that the rods themselves did not possess very marked contagious or infectious powers. Five weeks seemed to be the limit of the power of the rods to infect a healthy animal. But with the spores or germs, which, as we have seen, were developed from the rods, the case was widely different. Taking blood charged with the spores, he allowed it to dry. It was thereafter wetted and dried again, and otherwise manipulated. For four years it was kept in this state; yet, at the end of that period, when injected into the blood of mice, these animals developed splenic fever with great rapidity. The germs or spores of the rods acted, after four years' drying, as powerfully as if they had been newly taken from the blood of the infected animal. Thus was proved the interesting and all-important facts that splenic fever owes its origin to the rod-like bodies; that the spores of these rod-like bodies retain their virulent powers for years; and that the spread of splenic fever really means the diffusion of the spores or rods from one animal or herd to another. The rod-like plants received the name of *Bacillus anthracis;* and a study of splenic fever in the lower animals was thus seen to open up avenues of research into the diseases that affect mankind.

Since the period of Koch's discovery and researches, and, indeed, side by side with them, Pasteur, the famous French scientist, and other workers, have added largely to our knowledge of the "germ" origin of infectious diseases. Pasteur, for example, showed that where splenic fever broke out in districts which had been free from it for years, the infection was conveyed to the flocks in the soil above, by earthworms, which had brought the disease-germs to the surface from the diseased animals which had been buried deeply ten years before. From the worms, he obtained the matter lodged in their digestive system. Making an extract of this matter, he inoculated rabbits and guinea-pigs therewith, and found that they developed splenic fever in all its typical force, whilst their blood contained the characteristic bacilli. So also in the disease known as "fowl-cholera," Pasteur found the blood of the birds to be loaded with minute organisms (Fig. 2), resembling the *bacillus* of splenic fever. Thus whilst one *bacillus* propagating itself in the blood of the ox and sheep produces splenic fever, another (Fig. 2) when introduced into the blood of poultry, produces the "fowl-cholera," which the henwives of France and Switzerland know only too well. Many other forms of these lower organisms are also well known.

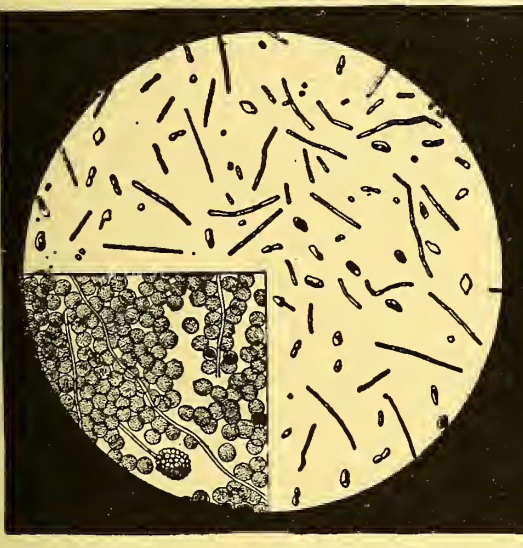


Fig. 3.—VIBRIOS FOUND IN DECAYING ANIMAL MATTER.

Fig. 4.—ANIMALCULES FROM VEGETABLE INFUSIONS.

The lower plants or *Vibrios* found in decaying fluids, or amongst putrefying meat, are shown in Fig. 3; whilst in Fig. 4 are shown the animalcules and other organisms which appear in infusions of hay, leaves, etc. These latter arise from their germs, which drop into the liquid from the atmosphere, and then spring into their adult forms of life.

An exceedingly interesting point in connection with the propagation and spread of these diseases, and one which also bears a distinct relationship to their mitigation and abolition, concerns the possibility of, firstly, rendering the germs innocuous, or less potent; and secondly, of protecting man and animals against the diseases in question, by inoculating them mildly with the modified disease. We know that the poisonous nature of the germs may be modified by one kind of cultivation, and intensified by another kind of attention. If the germs be cultivated artificially, that is, outside the body of a living animal, in such fluids as blood-fluid, or meat-juice, they lose their potency in time; so that an animal inoculated with the cultivated germs takes the disease, but in a very mild and trivial form. Again, after being inoculated with these milder germs, the animal is found to be protected against the serious malady. Twenty-five sheep were inoculated by Pasteur, with mild germs, on May 3rd, 1881, and again on May 17th; whilst other twenty-five sheep were left untouched. The twenty-five which had been inoculated exhibited slight symptoms of the fever, but soon recovered completely. On May 31st, all fifty sheep were inoculated with *strong* and potent germs. The result was very striking. The twenty-five which had been inoculated were unaffected; whilst the twenty-five which had been left free and unprotected by inoculation, died of the fever in its most virulent form. So also with the chicken-cholera (Fig. 2). By inoculating fowls, Pasteur has proved our ability to protect these birds against a malady highly fatal to those which are not inoculated.

Meanwhile research has been proceeding within the sphere of human affairs, in parallel lines to that which has effected such a wondrous change in the treatment of the maladies of lower life. Koch has shown that in the lungs of consumptive patients a *bacillus*, or rod-like organism, is present in quantity; but whether this bacillus is to be viewed as the cause, or merely as the result of that distressing malady, remains an open and much-debated question. Marsh malaria has also been shown to be accompanied by the presence of lower organisms; and typhoid fever, as well as other diseases, have each been undoubtedly proved to be associated with the appearance of living particles in the affected tissues. Tuberculosis, one of the most serious maladies that attacks our lungs, brain, and other organs, can be communicated by inoculation. The germs of the disease are thus conveyed from the diseased parts of the affected body into the healthy blood, and therein work all their characteristic mischief. There seems thus opening out before our eyes a wide field of investigation, fraught with the most beneficial results to mankind. No higher power can certainly be placed within human grasp than that which is capable of limiting the range of disease, of saving human life, and of making existence at once healthy and happy.

REMARKABLE LAND-TENURES.

SOME very remarkable tenures of land are pretty notorious. The following are not so generally known, and some of them are not only highly curious, but have considerable value from an historical point of view.

In the forty-first year of our third Edward, the manor of Overall, in the parish of Liston, was held by Joan Liston, by the service of paying for, bringing in, and placing five wafers before the king while he sat at dinner on the day of his coronation.

At the coronation of James II., the lord of Liston, in Essex, claimed to make wafers for the king and queen, and serve them at the royal table, to have all the silver utensils and other metal used at the same time, with the table linen, and certain of the ingredients and other necessaries, together with liveries for himself and two men. His claim was allowed, as it was when put forward by William Campbell, of Liston Hall, at the coronation of George III.

Keperland (or Coperland) and Allerton in Kent were held by the service of holding the king's head when he was sea-sick.

George Talbot, Earl of Shrewsbury, received by royal grant in the thirty-third year of the reign of Henry VIII. the site and precinct of the monastery of Worksop, with its appurtenances, in the shire of Nottingham; to be held of the king in *capite*, by the service of the tenth part of a knight's fee, and by royal service of finding the king a right-hand glove at his coronation, and to support his right arm on that day so long as he should hold the sceptre in his hand, and paying yearly £23 8s. 0½d.

At the coronation of James II., the lord of the manor of Bardolfe, in Addington, Surrey, claimed to find a man to make a mess of *grout* in the king's kitchen; and, therefore, prayed that the king's master cook might perform that service. This claim being allowed, the lord of the said manor brought up his mess of grout—whatever that might be—to the king's table.

John de Rockes held the manor of Winterslew in Wilts, by the service of making a pitcher of claret at the king's charge, and serving the king with a cup of it, taking the vessel, and any wine left in the cup, for himself.

Sir Osbert de Longchamp, knight, held Ovenhelle, in Kent, by the service of following his lord the king in his army into Wales for forty days at his own cost, with a horse valued five shillings, and a sack, worth sixpence, having a needle in it.

The manor of Brineston, in Chester, was held of the king in *capite*, by the service of finding a man in the king's army to go into Scotland barefoot, clothed with a shirt and breeches, having in one hand a bow without a string, and in the other an arrow unfeathered.

The manor of Finchingfield, in Essex, was held by one John Compes, of King Edward III. by the service of turning the spit at his coronation.

The manor of Loston, in Devonshire, was held by the serjeanty of finding "for our lord the king, two arrows and one loaf of oat bread when he should hunt in the forest of Dartmoor."

The manor of Chellington, in Shropshire, was held of the king in *cap te* by the service of finding one footman in time of war for the king's army in Wales, with one bow and three arrows, and one pale, and carrying with him one bacon or salted hog, and when he comes to the army delivering to the king's marshal a moiety of the bacon, and thence the marshal was to deliver to him daily some of that moiety for his dinner so long as he stayed in the army, and he was to follow the army as long as his half bacon lasted.

The manor of Morton, in Essex, was held by Henry de Averyng in *cap'te* by the serjeanty of finding one horse worth ten shillings, four horseshoes, one leathern sack, and one iron jug whenever he was called upon, to march for forty days with the king's army into Wales, at his own charges.

Peter Spileman held lands of the king by the serjeanty of finding an esquire with a hambergelt (coat of mail) for forty days in England, and of finding litter for the king's bed, and hay for the king's palfrey, when the king should lie at Brokenerst, in the county of Southampton.

GIVEN BACK BY THE SEA.—On the 26th of January, 1804, a ship of war, called the *Plantagenet*, famous for its having blockaded the French fleet for forty-eight hours, was caught in a terrific gale while working into Cawsand Bay. The mainmast was swept away, and in falling struck one of the midshipmen, who was standing on the main chains, and precipitated him into the sea. He was received by a huge wave, which caught up his senseless body and heaved it back upon the deck of the vessel, where it was at once laid hold of. He soon recovered, and laughed heartily when he heard the story of that benevolent wave.

PREMATURE GROWTH.

IN the record of the French Academy of Science for 1729, there is a description of a child seven years of age who was then nearly five feet high. His strength at four years old was so great that he was able to throw the ordinary bundles of hay into the rack of the stables, and at six years old he lifted as much as a strong labourer of twenty could carry. A similar account has been given of a child born in Bouzanquet, who, when four years old, was four feet three inches high, and when six had attained five feet, and had a beard. His voice was strong and manly, and he had all the appearance of a full-grown man. But while everybody was expecting him to speedily shoot up into a giant, the signs of growth ceased and those of age were as rapidly developed: his voice grew weak and before he had attained the years of manhood he was an imbecile, and feeble as a man in the extremity of old age. The old "Paris Memoirs" contain an account of a girl who was four feet six inches in height when four years old, with well rounded limbs and bust, looking like a girl of eighteen.

A CITY SAVED BY MILKMAIDS.

THE City of Dort, in Holland, at the time when that country was invaded by the merciless and cruel Spaniards, owed its safety to the presence of mind displayed by the milkmaids of a prosperous farmer residing on the confines; to commemorate which event it was commanded that all the money of the city, dollars, stivers, and doights, coined after the date of its extraordinary preservation, should bear the image of a milkmaid milking a cow. Some thousands of Spanish soldiers had succeeded in approaching the city unobserved, and were scattered about it in ambush, awaiting the signal for attack, when a group of milkmaids came amongst them, and saw them in hiding, but pretending they did not, went through their milking in the ordinary way, singing and chatting, and when their tasks were finished, trooped merrily back into the city, where they and their master at once spread the alarm. The Burgomaster of Dort sent out spies, and despatched messengers for aid; while others, letting the river into a certain sluice, flooded the surrounding country. The aid sought rapidly came, and the Spaniards, attempting to retreat, were overtaken by the flood, and many were drowned. The farmer who gave the alarm had his house, crops, and cattle destroyed by the water; but the States handsomely compensated him, and the milkmaid who first saw the Spaniards, and who quietly put her companions upon their guard, received a large sum of money, with a pension for her life, and that of her heirs for ever.

THE HISTORY OF PHOTOGRAPHY.

AMONG all the wonders recorded in the Arabian Nights Entertainments, there is nothing to surpass the marvellous power wielded by the modern Photographer. The very history of the art is a mixture of romance and reality, where accident has occasionally come to the aid of earnest research and patient study. Photography found its first initiation in those complicated labours of the old alchemists, who hoped, by the discovery of the philosopher's stone, to turn dross into gold, and so to make their fortunes in an hour. Their work was not in vain, for they learnt to some extent the nature and properties of several compounds, discovered others, and in a way cleared the ground for the birth of chemistry, a science to which we all owe so much. They found that a certain white salt, called the chloride of silver, would blacken gradually under the influence of light. Like many other observations which they made, this did not seize their attention, for it had little bearing upon the transmutation of the metals, and their goal was that. So for two hundred years this isolated fact regarding photography was allowed to sleep, until Scheele, the Swedish chemist, in 1777, first undertook an inquiry into this chloride of silver and its behaviour under light. What is this sensitive compound with which Scheele experimented? Mix a little common salt (the chloride of sodium) with water in a wine-glass, and add a few drops of a solution of nitrate of silver (lunar caustic). A heavy, white, flocculent mass results from the mixture, and soon settles to the bottom of the glass. This compound is chloride of silver, which if exposed to daylight, will speedily darken. By covering a flat surface with this sensitive salt, and allowing the shadow of a person's profile to fall upon it, the surface was blackened except where the shadow had protected it, the result being a white portrait on a black ground; exactly the same effect as any one might produce by cutting out a profile head in white paper, and sticking it on a piece of black material. Scheele also noted that the darkening action took place rapidly in white or blue light, but was so extremely slow in yellow and red light as to be scarcely perceptible. It is for this reason that photographers are able to deal with their sensitive compounds, so long as they are protected by yellow or red light.

Fig. 1.—PHOTOGRAPHIC NEGATIVE.

At the close of the past century two celebrated men, who have left their names on the scroll of fame in other fields of research—Davy and Wedgwood—turned their attention to the possibility of procuring sun-pictures. Wedgwood, in 1802, brought before the Royal Society a new method of copying pictures, which covered much the same ground as that previously traversed by Scheele. He brushed salted paper over with a solution of silver nitrate, thus forming on its surface a coating of that sensitive chloride already alluded to. Above this paper he placed in the sunlight any kind of opaque objects, so that the portions of the paper which they covered were protected from the influence of the light and remained white—the rest of the paper was of course darkened. Here was repeated the effect previously attained by Scheele, a white picture on a black ground. With this experimental picture closes the chemical history of photography up to the commencement of this century.

But the art depends upon the optician as well as the chemist, and to their joint labours it owes its present high position. In the sixteenth century the Neapolitan, Baptista Porta, had already contrived the camera obscura, by which the image of natural objects could be thrown upon a flat surface. The camera obscura is still a favourite piece of apparatus, and when used for public amusement—as at the Crystal Palace, for instance—it takes the form of a darkened room having an opening at the dome-shaped top furnished with a lens. A pivoted mirror outside this lens will reflect that portion of the outside view towards which it is turned through the lens on to a whitened table beneath, or the lens and mirror are more frequently combined in what is called a reflecting prism with one of its sides ground convex. A toy camera obscura can easily be made out of any small box, by placing a suitable lens at one end, and a screen of ground glass at the other end. Any object in front of the lens will be clearly depicted upon the inside surface of the ground glass—only in an inverted position—for the rays of light in traversing such a lens cross one another.*

Fig. 2.—POSITIVE PRINTED FROM THE NEGATIVE.

A ready means of delineating natural objects such as the camera afforded, was, as may be imagined, not only adopted as a means of amusement, but was also enlisted in the service of artists. A little dark tent, with a lens and mirror at its apex, and a table upon which to stretch a sheet of paper, comprised the entire apparatus. With such an arrangement the travelling artist could quickly dot down the lines of a landscape, with a correctness unattainable by any other means. A scene-painter at one of the Parisian theatres — Daguerre — was a constant worker with the apparatus, and as he worked he conceived the idea of endeavouring to make these fleeting sun-paintings into permanent pictures. For something like fifteen years Daguerre worked at this idea—which his wife looked upon as a craze, as idle and useless as the search for the philosopher's stone. Chloride of silver was far too slow to be roused into action by the feeble

* It will perhaps surprise those unacquainted with optics to learn that an image can be obtained without any lens whatever. A card with a pin-hole in the centre will, if held against a candle-flame, cause an inverted image of the candle to be thrown upon any white surface held near it. More than this, it is possible by such simple means to take a photograph. We have now before us a picture of a statue of the Prince Consort, which is perfect in every detail. It was taken by a modern rapid process in twenty seconds, in an ordinary camera; but the lens was replaced by a metal plate bearing a tiny hole.

light which reached it through the camera lens, so Daguerre had to look for something more sensitive. Such a compound was found in the iodide of silver, which Daguerre prepared by taking a silver plate and submitting it to the fumes of iodine. This iodised plate was then put into the camera so as to receive the rays of light reflected from the objects before it. Many times Daguerre tried this plan, but no image presented itself. One day, however, he happened to put away one of these plates—which had been tried in the camera—in a dark cupboard where there was a bottle of mercury. The next time he opened that cupboard there was on that plate a picture. The mercury, a very volatile element, had attached itself to all those parts of the plate where the light had acted, and a burnished picture was the result. This lucky accident led to that mode of taking pictures which is now a thing of the past, and which was known after its discoverer as the Daguerrotype process.

At the time that these events were passing in France, a notable advance in the history of photography was made by Fox Talbot in England, who had been experimenting with paper covered with silver chloride. He repeated Wedgwood's method of obtaining pictures by intercepting the light which fell upon the sensitive paper by pieces of lace, fern-leaves, etc. But having done this, and "fixed" his pictures by hyposulphite of soda, he made a new departure in using these white-on-black designs for producing duplicate copies. With another piece of sensitive paper placed beneath one of these pictures, the sun's light was made to blacken all those places where the white design allowed its rays to pass through. Therefore the reverse effect was produced, namely, a black design on a white ground. The first he called a Negative image, and the second he called a Positive. It will be seen that by adopting this plan any number of copies could be obtained from one negative ; but still the process was only applicable to such objects as could be represented in outline, the results being black and white, with an entire absence of half-tones.

Up to 1850 the daguerrotype was still the only process which would give a picture by means of the camera ; but it was slow in its operation, and had the further demerit of being incapable of multiplication, each picture requiring a separate protracted action of the camera before it was complete. In 1851 Archer introduced what must be still considered as the most successful method of taking a photograph ever invented, namely, the wet collodion process. Up to this time collodion (a mixture of gun-cotton, ether, and alcohol), had been used by surgeons in the treatment of wounds, as it afforded the means of forming a kind of artificial skin. Archer conceived the idea of making this delicate film the support of a photographic picture on a sheet of glass, but he mixed with it certain iodides and bromides. The object of this addition was to impregnate the film with the bromo-iodide of silver, which was easily done by immersing the collodionised glass plate in a bath of nitrate of silver. After being immersed in this bath, the glass plate becomes intensely sensitive to ordinary light, and therefore this immersion must only take place in a room in which the light is filtered through red or yellow glass. The plate so treated is then drained and placed in the camera to receive the image from the lens. Once more it is removed to the dark room, flowed over with a solution of iron, which reduces the salts of silver to the metallic state where they have been acted upon by the light, and a negative picture is the result. From such a negative, after being dried and protected with varnish, hundreds of positive prints may be obtained by allowing the light to shine through it upon paper prepared with silver chloride. Such, briefly, is the wet collodion process, which has given to us such brilliant pictures, not only of scenery and still life, but of our relatives and friends. Its advent laid the foundation of photography as an important industry. Those who have merely paid a visit to a studio for the purpose of having a portrait taken can have very little idea of what importance this industry has reached. Special paper is manufactured for photographers. Certain chemicals are used, and are prepared exclusively for them. They employ thousands of cabinet-makers in the construction of their apparatus. Opticians are kept busy in supplying them with lenses, while a busy photographer will be surrounded by quite a little colony of employés, male and female, who carry out all the details of his work.

Up to about the year 1879, it was considered, by those best qualified to judge, that Archer's process gave such perfect results, that it would never be superseded. It certainly had some disadvantages ; in the necessity, for instance, of requiring a dark room and many chemicals, and in necessitating the use of the silver bath. This staining bath of liquid caustic was the photographer's bugbear, and many experimenters soon began to consider whether they could not do without it. The first idea was to wash and dry the ordinary collodion plate directly it came out of its bath, but the results are very unsatisfactory and extremely slow in actual practice. Another plan consists in mixing the collodion with the sensitive chemicals, and to keep it in the dark ready for coating a plate of glass when required. Such plates can be used dry, and in some hands give remarkably good results ; but it may be said that until the above year there was not one process of sufficient merit to be in any way a rival to wet collodion. At last, about the year 1875, the virtues of gelatine as an aid to the photographer began to be talked about, and many experimenters succeeded in producing pictures by a process in which gelatine played a principal part. Still the process was only adopted by a handful of enthusiastic amateurs, and the professional photographer still held to wet collodion as his sheet anchor. Five years thus passed away, when suddenly a really practical recipe for making dry gelatine plates was published by Bennett, and he showed such astonishing results from it in the way of rapidity, that the photographic world was forced to pay attention to the new method. One after another the professionals adopted the gelatine process, and now there is hardly a studio where it does not obtain.

Briefly explained, the new process consists in mixing a sensitive salt—the bromide of silver—with warm gelatine, and spreading the mixture upon plates of glass, which are levelled until the gelatine solidifies; when dry, these plates are ready for use, and will keep indefinitely. Moreover, their development can be postponed for a long period after their exposure in the camera, so that it becomes possible for a traveller to take a stock of prepared plates abroad with him, without being burdened with a single bottle or chemical preparation. Such plates he can expose in his camera, and can develop the latent image upon them when he returns home, it may be months later. Apart from this undoubted advantage, which reduces a photographer's kit from a tent containing a laboratory to a packet which can be carried in the hand, the gelatine process is so rapid in its action, that pictures can be taken of all sorts of moving objects. An express train travelling at the rate of sixty miles an hour is not quick enough to escape the modern photographer. More wonderful still, a forked flash of lightning has more than once been made to stamp its image upon a gelatine plate. Special appliances are necessary for this instantaneous work, and a description of them, and of some of the results obtained by their use, may form the subject of another article.

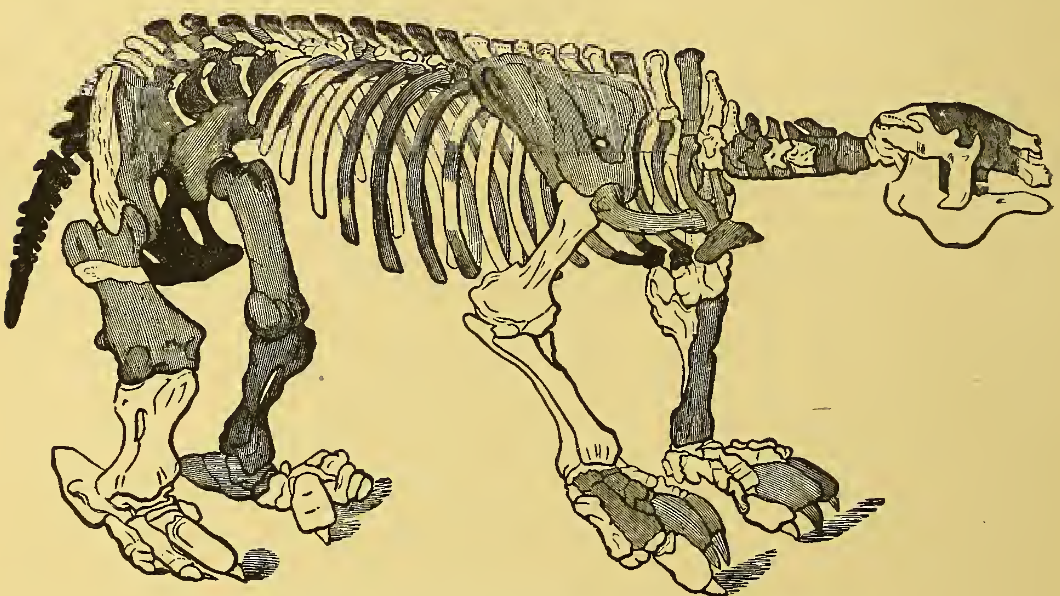
A Wonderful Rose-tree.—A rose-tree, growing at the New Gardens, Whitby, has justly attracted a good deal of attention from florists and horticulturists, as well as from the general public. The variety is that known as the Marshal Niel. The tree was planted about 1864, and the extremity of its growth, horizontally, is no less than 102 feet—48 feet to the left, and 54 feet to the right of the parent stem respectively. The average depth of the tree is 5 feet or 6 feet. In 1881 no fewer than 2,500 roses were plucked from it, and this extraordinary quantity was greatly exceeded in 1882, nearly 4,000 blooms having been counted in that year.

THE MONSTER SLOTH AND ITS CONTEMPORARIES.

In the year 1788 the remains of an animal of gigantic proportions were found in a bed of clay on the banks of the Luxor, about twelve miles W.S.W. of Buenos Ayres, Paraguay. They were evidently the bones of some extinct animal, for there was no creature living with such massive limbs. Its thigh-bone was twice the thickness of the thigh-bone of the largest elephant; it had a foot at least a yard long; yet, singular to say, its head was a comparatively small one. The bones were brought to Madrid, and set up in the Royal Cabinet of Natural History there. The accompanying illustration is a representation of the skeleton, which, it will be observed, is not quite complete, as the inner portions of the pelvis, or haunch-bones, are wanting; also the tail, portions of the ribs, and other parts.

What could the animal be? Great mistakes have been made in discussing the nature of extinct animals when the bones have been dug up for the first time. Three hundred years ago such a "find" as that of the great fossil animal of Paraguay would have been confidently taken for the bones of one of the human giants which, according to tradition, lived on the earth in past ages; and no attempt would have been made to build them up in their original positions. The discovery being made, however, when anatomy had already made important strides, the *savants* confidently came to the conclusion that it was the skeleton of an extinct sloth—an ancient representative of the creature which at the present day lives in the trees of South America, suspended from the branches by its claws, and feeding on the leaves and twigs. Cuvier christened it *megatherium*, which means *great monster*. It was very evident that the habits of the megatherium, weighing tons, must differ from those of the modern sloth, which is a comparatively small animal. It was absurd, for instance, to suppose that the megatherium ventured on to the branches of trees in quest of food; for they would have been inevitably snapped off by its weight. A close study of the structure of its skeleton has enabled naturalists to form some idea of its habits; and this study has been facilitated in this country by the excellent specimens brought from South America and presented to the Museum of the Royal College of Surgeons in 1832 by Mr. (afterwards Sir Woodbine) Parish. These specimens were obtained under the following circumstances:—The river Salado in Buenos Ayres being lower than usual on account of continued drought, a large bone projected above the surface of the water. It was lassoed by some of the inhabitants, and brought to shore. It turned out to be a gigantic pelvis, or ring, formed by the haunch-bones of some extinct animal. It was so large, measuring five to six feet across, that two men could readily get through it. Sir Woodbine Parish obtained this singular fossil from the authorities of Buenos Ayres, and immediately set about to get the remainder of the bones which formed the other parts of the skeleton. The Salado was dragged, and in one part even dammed off and diverted from its usual course. By these extraordinary measures he managed to get the skull, bones of the spine, of the tail, of the hinder extremity, and the shoulder-bone, from which it was ascertained that they belonged to the megatherium. Curiously enough, the bones wanting in the Madrid specimen were supplied by this discovery.

America. The mastodon, big and strong as it was, must have been a comparatively feeble animal by the side of the megatherium. The enormous strength and weight of the hind-quarters have led to the belief that the beast rested on its haunches and tail while it used the arms and enormous claws with which the fore-feet were provided to tear down branches and uproot young trees. It has also been thought that it dug with its claws, working first with its fore feet, and, after accumulating a certain amount of earth, using the hind feet to clear it away. When a large bony shell, or shield, as large as a brewer's boiler, was discovered in the same district of Buenos Ayres, it was surmised that this



THE MADRID SKELETON OF THE MEGATHERIUM. (*Missing parts shaded dark.*)

That the megatherium was an animal of immense strength is shown by the ridges on the bones being strong and projecting, which is only the case where the muscles are powerful. The thigh-bone, for example, which is two feet five inches long and three feet four inches round its thickest part, has ridges standing out from it for the attachment of muscles, which may be said to show that those muscles were of extraordinary power. The bones of the leg are joined into one compact bone, instead of being in two long pieces side by side, as is usually the case. The heel-bone is more than a foot in length, and, therefore, was a powerful lever for the muscles which acted on it. Indeed, so strong must the megatherium have been, that although, as we shall presently see, it was an inoffensive animal, its very strength would make it respected as it slowly and ponderously moved about the pampas of South

was a natural protection to the megatherium against the descending masses of earth which it was conceived it had the power to fling upwards while digging. This hypothesis was dismissed, however, when it was subsequently proved that the carapace belonged to the glyptodon, another giant of those times, which we shall presently have to mention. To sum up: the full-sized megatherium was great, strong, and shaggy-coated; it was from six to seven feet high, twelve to thirteen feet long, with a tail two feet in diameter; it had a sleepy, ursine face, and an elongated snout. The claws of its feet would appear most formidable instruments, standing out like huge hooks from feet a yard long and a foot broad. Yet the megatherium was a harmless animal, for it belonged to an order of quadrupeds without front teeth (*Edentata*), which includes the sloth, ant-eater, and armadillo.

To the naturalist, its kinship to the existing sloth is very apparent in the similar structure of its skull, blade-bone, and other parts ; in both, the teeth are the same in number, kind, and structure, &c. ; and these are the facts which lead him to suppose the megatherium fed on leaves and succulent branches of trees, only it obtained them in a very different way from the sloth of the present day.

There were several other gigantic beasts living at the same time, and neighbours to the megatherium, not quite so big as it, but as remarkable in other ways. Among them we may mention the megalonyx, mylodon, and glyptodon.

The megalonyx had a general resemblance to the megatherium, but was of slighter build, being about one-third smaller. Like the larger animal, it was probably a harmless creature, although, when some bones of the legs, feet, and breast, together with three claws, were first discovered in a cavern of Western Virginia, they were supposed to be those of some carnivorous animal. President Jefferson described it as a great lion, bigger than our largest ox, and probably the enemy of the grand mastodon and the other huge creatures which lived then. But an examination of the bones connected with these claws led Cuvier to the conclusion that they were never used for any more hurtful purpose than those of the megatherium ; and he demonstrated that the megalonyx could not have been a lion, and that it was probably a peaceful leaf and twig-eating sloth. The remains of the megalonyx have been found along with those of the megatherium at Punta Alta, South America.

MYLODON RESTORED.

The mylodon, also an extinct sloth of the pampas, was smaller than the megatherium, and, like it, was a vegetable-feeder. There is a skeleton of one in the Hunterian Museum which measures eleven feet in length from the muzzle to the extremity of a comparatively short tail. It was of massive build, having ribs as stout and broad as those of the elephant. It had hind feet as long as its thigh-bones; five toes on each fore foot and four on each hind foot, with the big toes and some of the others armed with great claws. The feet were hoofed. It may have climbed up the trunks of strong trees and wrenched off the branches when seeking food, but on to the branches themselves it probably did not venture, on account of its weight.

The great shell, or carapace, we just now mentioned, is now known to have been the shield of the glyptodon, a contemporary of the megatherium. It was an animal nearly allied to the armadillo, but of a size which makes the armadillo of the present day look like a pigmy. Its body was protected by a great shield, devoid of the bands or joints which make it flexible in the armadillo. Its hind feet were broad and massive, and it had short, thick, depressed claws. With regard to size, it must sometimes have attained to a length of ten or twelve feet, or even more, as portions of carapaces have been found which would be this length when complete. The tail was enclosed in a bony sheath, and the teeth had a couple of deep grooves dividing them lengthways. From the latter fact it has been named *glyptodon*. An approximate idea of this creature's general form may be obtained by imagining an armadillo to be swollen out until it has attained to a length of ten feet, with all its parts made of proportionate size.

These and other large animals lived on the pampas of Buenos Ayres, and in other parts of the New World, during the Pliocene age. One asks, with some curiosity, What caused them to die out ? There appears to be every reason to believe that they may have succumbed to periods of drought, which, even in our own time, occasionally cause a vast loss of animal life on the South American continent. It has been suggested as highly probable that, during prolonged droughts in the age in which they lived, they were driven by thirst to the rivers in a weak and emaciated state, and, sinking in the mud and clay of their exposed beds, perished.

TOUGHENED, OR TEMPERED GLASS.

THE art of glass-making is so old that its first discovery, or the nation who first worked the material into manufactured articles, are alike lost in obscurity. Pliny says that its discovery was an accident. He then proceeds to describe how certain Phœnician merchants, lighting a fire to cook some food on the seashore, piled up some lumps of vitreous stone to serve them as a fireplace. The heat melted the stones and the sand on which they stood, and so caused glass to be formed. This story has been handed down and repeated so often in various books, that it has assumed a position it does not deserve. Its truth must at once be called in question, when we remember that glass bottles with Chinese inscriptions have been found with many of the Egyptian mummies. We may therefore assume that the clever Chinese were the first producers of glass, as they were the first to discover the properties of the magnet, of gunpowder, &c., and that glass reached Europe through a trade channel which undoubtedly existed before the founding of Athens.

Glass has been found in the windows at Pompeii, and we know, from specimens which are extant, that the Romans were well acquainted not only with its manufacture, but they knew how to blow it, to stain it, and to engrave it, so as to make it serve for purposes of ornament. Unfortunately, from its extreme brittleness, these specimens are very rare. Indeed, we may assume that the earliest workers of glass must have deplored, as we do in this present day, that things so beautiful should be so very fragile. Of late years more than one process has been invented to counteract this failing, and so to temper glass in its manufacture as to make it withstand ordinary shocks without breaking. To a brief description of the means employed to accomplish this desirable end we will now direct the reader's attention.

In the ordinary operation of glass-making, certain silicates are fused together and blown or moulded into shape according to circumstances. Articles so made would, if at once lowered from their heated condition to the temperature of the atmosphere, be so brittle that a mere scratch would suffice to reduce them to fragments. The exterior would harden before the interior had time to do so, and the particles within would be held by the outer crust in a strained condition. It becomes necessary, therefore, to avoid this strain by the operation called annealing, which consists in consigning the heated articles, directly they leave the workman's hands, to a brick oven, where their temperature can be very gradually lowered. "Rupert's drops," which can be purchased of most opticians, form examples of unannealed glass. They are prepared by dropping molten glass into cold water, and assume the form of round drops with a long tail attached ; the least abrasion of this filament causes the glass to fly to pieces.

But even with the help of the annealing oven, we all know that glass is still one of the most brittle substances we have to deal with. Mons. de la Bastie was the first to endeavour to obviate this disadvantage. He considered that the fragility of the material was due to the weak cohesion of its molecules ; and his first experiments were undertaken with the idea of subjecting the glass to compression while in a soft state, so as to bring its particles more closely together. These experiments seem to have been unsuccessful ; after which the same investigator introduced a process of a practical nature which he has patented.

In this process, the glass, after manufacture, is placed in a special form of oven where it can be brought to a certain temperature, very near its melting-point. In close proximity to this oven is a bath which may consist of wax, resin, oil, or any description of grease, also brought to a high temperature. By simple mechanical arrangements, the glass articles can be removed from the oven and transferred to the dipping-bath. After this treatment the glass is found to have lost its brittleness to such an extent, that a thin sheet of it will support a man's weight : and a basin, cup, or plate tempered in the way described, can be thrown from one end of a room to the other without risk of breakage. Unfortunately sheet glass so treated has the peculiarity that it cannot be cut with a diamond, the least scratch with that instrument causing it to fracture.

It is the unfortunate lot of successful patentees to find numerous imitators ; although imitation in this connection can hardly be described as "the sincerest form of flattery." After De la Bastie's process became known, patents for tempering glass speedily multiplied. Siemens' process is perhaps the most successful of these, as far as can be judged by published reports of the results achieved by it. In this process the glass is placed in moulds and subjected to pressure ; the material of which the mould is made depending upon the thickness of the glass. Where it is necessary to cool the article somewhat rapidly, the mould is made of copper, or of some material which, like copper, is a good conductor of heat. When the article is to be more slowly cooled, earthenware is employed for the mould. But in the majority of cases, cast iron is found to be the best and most satisfactory agent for the purpose. Liquid glass can be transferred direct to the mould, being lifted from the crucible in the usual way on the blower's pipe and shaped in the mould itself. But where articles are of such a nature that their shape might suffer under the pressure employed for the hardening process, casings or shells of platinum are used, which, to gether with the glass, are transferred to the moulds.

A rather startling, but successful, application of Siemens' process is the production of glass sleepers for railways. That these are tough enough to bear the required strain is evidenced by certain trials to which they were subjected before being laid down experimentally on one of the North London Tramways. A square of tempered glass, little more than one inch thick, was laid on a bed of gravel. Above this plate was suspended an iron weight of nine hundredweight. It was allowed to drop upon the glass from various heights, beginning at three feet, and increasing the distance by about two feet every time. It was not until the weight was dropped from a height of twenty feet that the plate broke.

It is evident that both processes have their drawbacks. In the first described, the bath of hot oil or grease is apt to fire directly the heated glass is plunged within it. In Siemens' process the bath is dispensed with, but the employment of such a costly metal as platinum is decidedly a disadvantage. We may perhaps assume that both processes possess advantages in the production of certain articles; the first being more suitable for ornamental manufactures, and the latter for rougher productions, such as sheet glass, and the sleepers already described.

One more method of tempering glass is that of Herr Pieper, who submits the material while at a red heat to the action of super-heated steam. That the German glass-workers think highly of this process is proved by the large sum which they have paid for the right of using it. But we have no data at hand on which to base comparison with the older processes of De la Bastie and Siemens.

A CATARACT OF OPAL.

THE features of the district which are about to be described are, it is believed, unique, no other such natural phenomena being known in any other part of the world. It must be premised, however, that no description can convey a correct idea of what they are; a day spent among them is a new sensation, and must be felt to be understood. The nearest approach to such scenery occurs in the Yellowstone Park, near the junction of the Yellow River and the Missouri, in the United States.

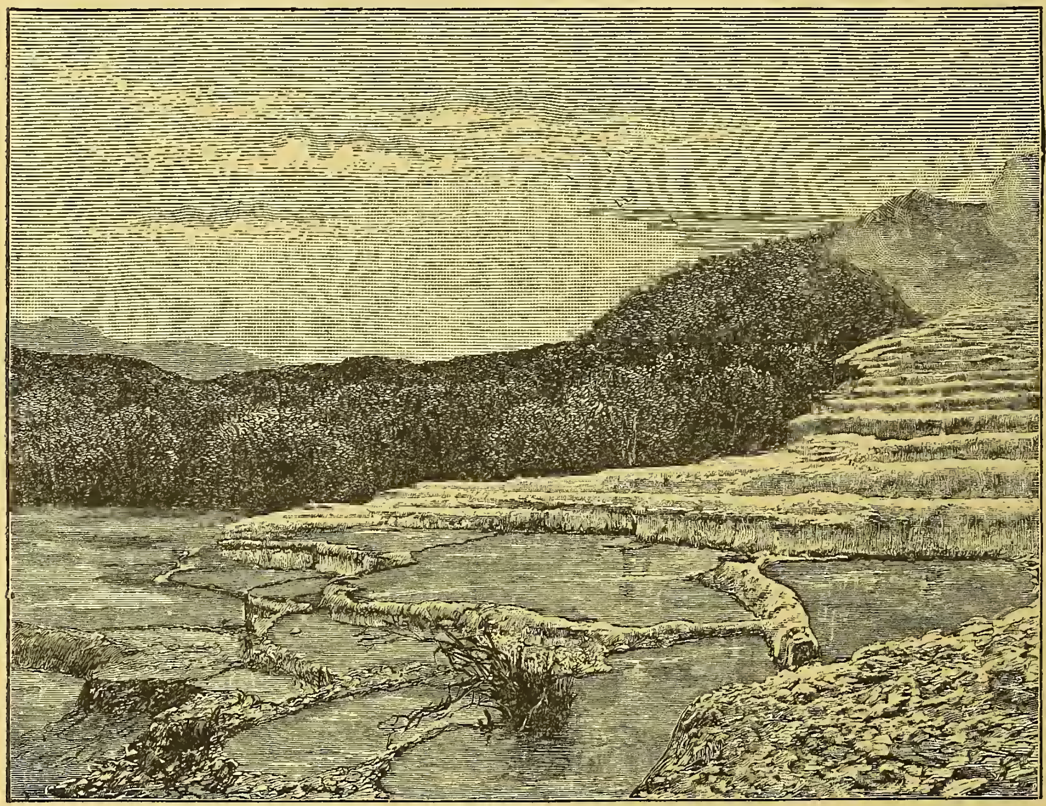
Nearly the whole of the northern island of New Zealand is volcanic, which is easily seen by the numerous craters scattered up and down the country; as many as sixty-five may be counted within a radius of five miles from Auckland. The centre of present volcanic activity lies near the two mountains of Pongariro and Ruapehu, 200 miles south of Auckland. From this, in a N.N.W. direction, three very distinct and diverging "lines of fire" may be traced, one of which terminat s in White Island, in the Bay of Plenty, on which, among other phenomena, occurs a crater-lake, the water of which contains the unprecedented quantity of 11,000 grains per gallon of free muriatic or hydrochloric acid.

Almost due north of the volcanoes, and in the centre of the island, lies the very large Lake Taupo, 1,250 feet above the sea, which, there is very good reason to believe, supplies water to the innumerable hot springs, geysers, &c., along the "lines of fire" already alluded to. Between Lake Taupo and the coast of the Bay of Plenty is a territory known as the hot lake district, which has hitherto been occupied solely by the Maories, but, under the "Thermal Springs Districts Act of 1881," has just been rendered available for settlement by Europeans and the colonists, and the township of Rotorua has been laid out on the shores of the lake of that name (Rotorua—hole-lake, or lake in a circular excavation), the largest in the district. In the immediate neighbourhood are a large number of mineral springs, very variable in composition, but all more or less curative in their properties, ranging from the boiling cauldron of Oruawhata and the scalding steam-jets of Sulphur Point, to tepid lake-shore and cold sulphurous springs.

A mile and a half from the town occurs the large group of hot and boiling springs known under the general name of Whakarewarewa, with a large geyser throwing boiling water high into the air, and depositing white silica all round, like a miniature of the terraces of Rotomahana, shortly to be described. Of the many thousand hot and cold springs that bubble around in every direction, only a few have been analysed and reported on, but enough has been done to show that the diff rent chemical combinations are practically without number, no two pools being alike. Dr. Hector, F.R.S., Director of the Geological Survey of the colony, classifies them into saline (and ferruginous), alkaline, alkaline silicious, hepatic or sulphurous, and acidic. In fact, all the mineral waters of Europe seem to find their representatives here, even to the rarest, and in addition there are countless mud-baths, mud-volcanoes, &c., in wandering among which the greatest care has to be taken by the pedestrian.

As remarked by Miss Gordon Cumming, all the ordinary cares of housekeeping are here greatly facilitated by nature; she provides so many cooking pots that fires are needless, all stewing and boiling does itself to perfection; laundry work is equally easy: certain pools are set aside in which to boil clothes, and the waters, being alkaline, produce a cleansing lather.

About twenty miles to the east of Rotorua and the famous old Maori Pa of Ohinemutu, is the world-renowned Rotomahana, "warm lake," which is one of the smallest in the district, being barely a mile from north to south, and a quarter of a mile wide. The quantity of water running from the ground, both on the shore and at the bottom of the lake, is truly astonishing; the whole lake is heated by it, but the temperature varies in different parts, according to the proximity of the hot springs, which must be avoided by the bather. Its mean temperature may be taken at slightly above 80° Fahr. No fish or mollusca will live in it, but it is a favourite haunt of countless water and swamp fowls, which have their brooding-places on its warm shores, while they seek their food in the neighbouring cold lakes.



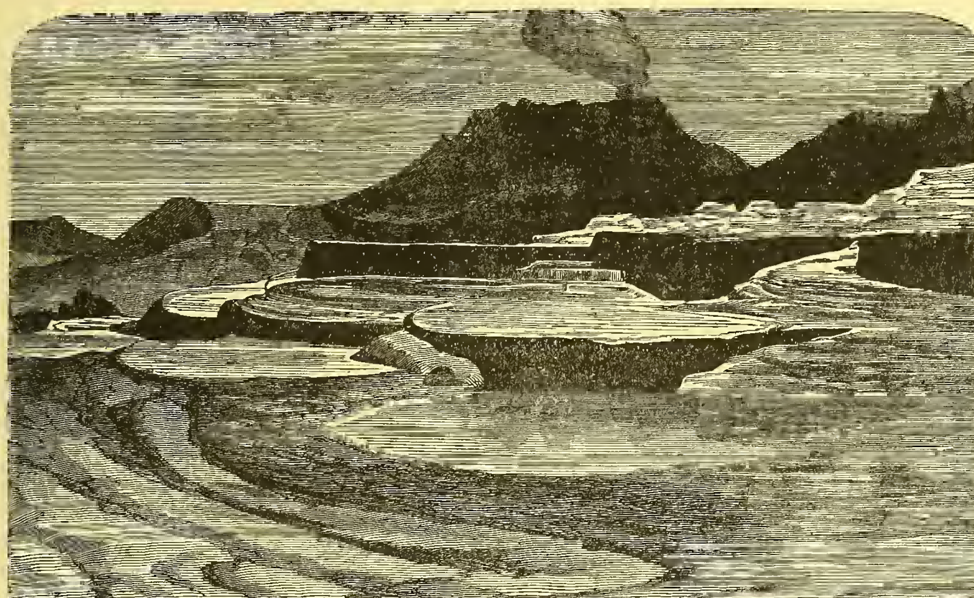
THE WHITE TERRACE, ROTOMAHANA. (*From a Photograph.*)

The unique and marvellous features of the lake, however, are the celebrated pink and white terraces, whose general appearance is perhaps best conveyed to the reader by asking him to conceive of a huge cataract or cascade of water rushing down into the lake, and suddenly turned into an immovable mass by some fairy power. The material of these terraces is a very light white porous substance, deposited from the overflow of huge hot springs, some ninety or a hundred feet above the level of the lake, and it is composed entirely of pure silica and water, being, in fact, a hydrate of silica, resembling closely in composition that beautiful precious stone, the opal. Under certain conditions of sunlight the most lovely colours are seen in different parts of the terrace, which may therefore be not inaptly described as a cataract of opal.

The Te Tarata, or white terrace, rises by a succession of chiselled steps, till it attains an elevation of about eighty feet above the lake. Here, backed up by a semicircular wall of red rock, on the level plateau of the uppermost terrace, is the great boiling *puia*, the downward flow of whose waters, impregnated with silica, has, in the course of centuries, deposited the "tattooed" rockwork of which the Tarata is composed, and from which its name is derived. Upon the "treads" of several of the steps (which vary in height from one to about seven feet each) of the terrace have been formed beautiful cisterns, in which the water lies semi-transparent and still, of the most exquisite turquoise-blue colour, surrounded by a rim of beautifully sculptured, almost snow-white, opaque rock, from the margin of which the most delicate stalactites hang down till they almost touch the lower stage. The contrast of this colouring with the deep red of the rocks surrounding the lake, the dark olive-green of the luxuriant vegetation environing it, relieved by numberless white jets of steam from other hot springs, and the intensely blue sky above, presents a picture unequalled by anything known to such experienced travellers and observers of natural phenomena as Mr. Alfred Russell Wallace. The temperature of the water in the basins varies, of course, with their height upon the terrace and their distance from the spring-source, and accordingly the bather can choose that most suited to him, or enjoy a graduated succession, as may most please his fancy. The flat-spreading foot of the terrace extends far into the lake, the surface of which is studded with large and small detached pieces of the siliceous deposit, floating about like so many miniature icebergs. Those who have visited the Marjelen Lake at the edge of the great Aletcsh glacier in Switzerland, with the tiny icebergs constantly falling into it, will be able to realise this effect. To various characteristically-shaped portions of the terrace names have been given, suggested by their fancied resemblance to different natural objects. The whole neighbourhood is full of the remains of other terraces, which have existed at no very distant period, and their fantastically-shaped rock-masses add to the marvels of the scenery surrounding the lake.

The other terrace, Otukapuarangi, commonly known as the pink terrace, from its soft salmon-colour, lies at the opposite end of the lake. Except in the particular of colour, which is probably due to the presence of a very minute trace of iron with the hydrated silica, it is less remarkable than the Tarata, being decidedly smaller, and presenting fewer facilities for bathing, although the same general characteristics of structure occur in it.

It will now be desirable to describe more in detail the hot springs that produce this remarkable phenomenon, and especially the one at the top of the Tarata, which is a true geyser. The basin of the spring is about eighty feet long and sixty feet wide, and filled to the brim with perfectly clear transparent water, of the same turquoise-blue that is seen in the lower basins, and to a less extent in the waters of the lake itself. The temperature of the water at the margin is 183° Fahr.; but there can be little doubt that it closely approaches, even if it does not exceed, 212° in the centre of the funnel-like basin, from which immense clouds of steam are constantly rising, obstructing the view of the whole surface of the water.



GEYSER ON THE TOP OF THE TARATA.

The level of the water in this natural cauldron varies considerably at uncertain periods, and hence the discharge of water down the terrace, which arises from the overflow of the spring, is intermittent, and subject apparently to no fixed law. It occasionally happens that the whole mass of the water is suddenly thrown out with immense force; when this occurs, the empty basin is seen to a depth of thirty feet, but it fills again very rapidly. This condition of things has been perpetuated in a photograph in the possession of the writer, and usually occurs only during violent easterly winds.

The water, according to an analysis made in the Colonial Government Laboratory, contains 153 grains of solid residue per gallon, of which thirty-nine are silica, sixty-seven soda, and thirty-nine chlorine. Hence it is practically a weak solution of silicate of soda and common salt. When it is exposed to the air, and cooled, the silicate of soda is decomposed, probably in great part by the carbonic acid of the air, and the insoluble silica deposited in a hydrated condition upon whatever the water flows over in its descent into the lake. The deposit forms very rapidly; a bird shot flying over the terrace, and falling upon it, was completely incrusted in a fortnight.

The pink terrace has been built up round a great circular pool 180 feet in diameter, from which there is an almost constant outflow of clear bright water, at a temperature of 204° to 208°, containing 166 grains of solid residue per gallon, of which forty-six are silica, fifty soda, and fifty-seven chlorine. In consequence of the smaller proportions of soda and the presence of sulphuric acid, Dr. Hector considers that a large proportion of the silica in this spring exists in the free state in solution in water.

RIPPLE-MARKING ON THE OPAL ROCKS.

It is somewhat remarkable that these deposits should be so entirely composed of pure hydrated silica, notwithstanding the large amount of common salt in the springs; according to an analysis by the writer, the impurities do not amount to one per cent. It would appear as though the water, in trickling over the terraces, aided, no doubt, by occasional rain-storms, dissolved away all the extraneous salts. No doubt these beds of pure silica scattered over the country would have a high commercial value for the manufacture of the very finest kinds of glass and porcelain, since it is extremely difficult to get such entirely free from iron and other metallic oxides, which are apt to colour the ultimate product; up to the commencement of 1882, however, when the Thermal Springs Act, before alluded to, began to come into operation, it was difficult for a tourist to obtain even a small specimen of it. The reason of this was that, as explained above, the whole district formed part of the Maori reserve, and was inhabited by them; they had proclaimed the terraces *tapu* (sacred), and forbade any traveller to remove portions of the terraces. As it was necessary to obtain the services of Maori guides, to avoid accidents on ground where there is only a fragile crust between the traveller's foot and boiling water or scalding mud, compliance with these regulations was almost unavoidable. At certain seasons of the year, too, the various water-fowl frequenting the lakes were also proclaimed *tapu*, and the Europeans and colonists were then prevented from shooting them.

It is not too much to say that there is probably no country in the world where, within a small area, so many and so great a variety of facilities exist for bathing in, and drinking, every kind of medicated water; and there are several localities which, from their wealth of hot springs and fumaroles, appear more particularly adapted for sanatory purposes.

As remarked by the Hon. Sir W. Fox, K.C.M.G., the district might be, and is probably destined to be, the sanatorium not only of the Australian colonies, but of India and other portions of the globe. The country in which the hot springs are, is not attractive for agricultural or pastoral or any similar purposes; but when its sanatory resources are developed it may prove a source of great wealth to the colony; and not only so, but it may be the means of alleviating much human misery, and relieving thousands from their share of the ills that flesh is heir to. What is wanted is simply practical skill enough to make water run in pipes where it is wanted, and accommodation for those who may desire to avail themselves of it. Both these objects seem likely to be attained in some degree by the proclamation of the whole district under the "Thermal Springs Districts Act, 1881," and by the establishment of the projected township of Rotorua, before alluded to.

ELECTRICITY AS A MOTIVE POWER.

In the year 1833, Dr. Schultless, who had made several suggestive experiments with the electro-magnet with a view to its employment as a motor, wrote as follows:—"If we consider that electro-magnets have already been made which were capable of carrying 20 cwt., and that there is no reason to doubt that they can be made infinitely more powerful, I think I may boldly assert that electro-magnetism may certainly be employed for the purpose of moving machines."

There were many other clever men at that time who held the same view. The marvellous power of attraction exhibited by even a small electro-magnet impressed their minds with the belief that it might easily be made to actuate machinery. Moreover, the magnetism can be destroyed and restored with such ease and rapidity, by merely making and breaking connection with the battery, that it was seen that an armature could be made to give alternate movements, which by suitable gearing could turn a wheel. The piston-rod of a steam-engine represents such alternate movements, and we all know how, by the simple device of a crank, the to-and-fro movement is changed to one which is rotary. In the steam-engine there is no difficulty about length of stroke, that is merely governed by length of cylinder and supply of steam. But supposing that we wish to carry out the same movements with a magnet and armature, we are at once met with the difficulty that the magnetic attractions decrease very rapidly with increase of distance, so that the length of stroke is reduced to something infinitesimal.

In 1835, Professor Jacobi, of St. Petersburg, was, under the patronage of the Emperor Nicholas, employed in making a series of experiments in this direction which were carried out regardless of expense. He began by employing magnetic bars which by their attractive and repellant powers were made to exert a rocking motion, which was subsequently converted into a rotary one. He was the first to discover a very important point, the non-observation of which had caused many other inventors to fail. The soft iron of which the magnets are made, if subjected to repeated shocks against an armature, gradually changes its nature and becomes so like steel that it retains a certain portion of the magnetism, and its power as an electro-magnet becomes considerably weakened.

Jacobi soon abandoned the oscillating type of machine in favour of a new pattern (see Fig. 1). He fixed eight electro-magnets on a disc with the same number on a framework placed around it. When the disc was rotated the poles of the moving magnets almost touched those which were stationary, and by an ingenious arrangement the magnetism was cut off after each approach, to be renewed again before the next magnet was reached. This engine was subsequently fixed on a boat and geared to a pair of paddle-wheels. The boat was twenty-eight feet in length, drew two and a half feet

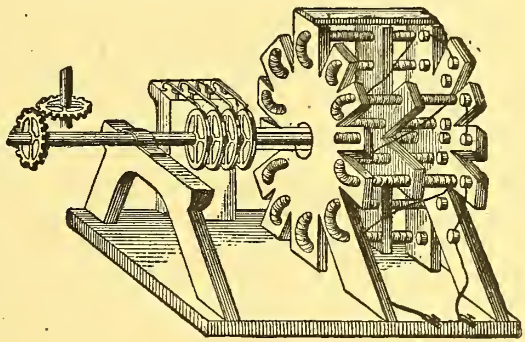


Fig. 1.—JACOBI'S MACHINE.

of water, and carried a dozen passengers. The electric current was of course supplied by battery-power, and the energy obtained from that source was computed to be one horse-power for every twenty feet of platinum exposed to chemical action. With increased battery-power the same boat appeared once more on the Neva, carrying fourteen people at the rate of three miles per hour against the stream. At about the same time that this electric boat was astonishing the people of Russia, Davidson, of Edinburgh, had contrived a locomotive electro-magnetic engine which was sixteen feet in length, and weighed five tons. It was tried on the Edinburgh and Glasgow Railway, but as its highest speed was only four miles an hour it soon passed into oblivion.

Professor Page produced an electro-magnetic engine on another principle, which bore a stronger likeness to a steam-engine than those which had gone before. He used a helix of wire—which we may call the cylinder—and in this hollow coil a kind of plunger or piston-rod, worked in and out by the magnetism induced in the wire. Professor Page estimated that he obtained from the battery consumption per day of 3 lb. of zinc, energy amounting to one horse-power. But this estimate is, to say the least, very doubtful. Bourbouze, in France, produced an engine on exactly the same principle; whilst another Frenchman, Froment, designed one more on the pattern furnished by Jacobi. Particulars and drawings of these engines may be found in most of the French standard works on Physics.

Such has been the rapid progress of electrical science that the various ingenious machines just described, although not yet fifty years old, may be said to comprise the "ancient history" of electromotors. We see that success to a certain extent was achieved, and many will wonder why, with such ingenuity and perseverance, this success was not more marked and more lasting. To answer this question, we must take two or three things into consideration. The first difficulty these inventors encountered was the battery, which represented their sole source of electrical energy. A powerful battery, if required for regular work, is but a broken reed to depend upon. Uncertainty of action is influenced by quality of zinc, amalgamation of the plates, strength of acids employed, cleanliness of connections, which are constantly liable to corrosion, and many other matters the importance of which can only be appreciated by any one accustomed to battery work. But supposing all these difficulties could be surmounted, a still more serious one is met with in the cost of zinc. Zinc is consumed in a battery much in the same way that coal is burned under a steam-boiler, and it is by no means difficult to see which is the more expensive way of obtaining a given amount of energy. In the modern doctrine of "conservation of energy," we are taught by Joule that a certain quantity of heat is always equivalent to the same quantity of work: it does not matter a bit in what manner the heat be produced. If we endeavour to ascertain the amount of heat obtained from burning a pound of zinc and a pound of coal respectively, we shall find that the latter will give us about seven times more work than the former. Now, as zinc costs about twenty-five times as much as coal, we have only to multiply that sum by seven to find out how costly an engine worked by battery-power must be. Motive power is as much influenced by cost of production as the price of the more tangible things which we see displayed for sale in our shops.

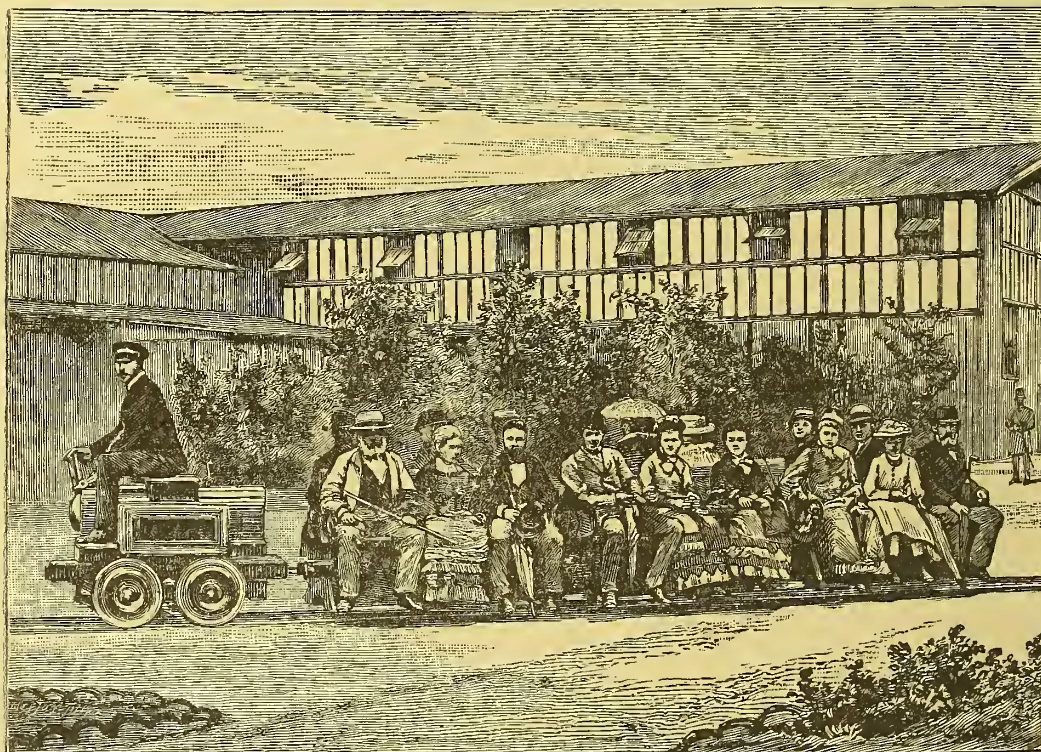


Fig. 2.—ELECTRIC RAILWAY AT BERLIN, 1879.

The modern history of motion by electricity is comprised in the recent development of the

"Dynamo machine," and its germ lies in the circumstance that all machines which give continuous currents are reversible. In other words, suppose we have before us a Gramme machine geared in the usual way to a steam-engine, to this first machine we couple another by means of copper cables, which may be of any reasonable length. Directly the armature of the first machine begins to rotate, that of the second one will rotate in the *reverse* direction. This discovery, which was probably noticed by many, and regarded by them as simply an interesting scientific experiment, was declared by the late Professor Clerk Maxwell to be the greatest scientific discovery of the past twenty-five years. With wonderful foresight he saw how the Gramme and other machines could be employed in quite a new service. Constructed merely to furnish a current which could be utilised for light, heat, or other purposes, this same current, by the agency of a distant machine and intervening wires, could be made to *transmit power* to a distance, the limit of which is not yet known.

Let us see how far Professor Clerk Maxwell's anticipations are being borne out by actual events. In an article on Incandescent Electric Lamps we showed how, at Sir W. G. Armstrong's country house, where such lamps are in use, the electricity is obtained from a dynamo machine worked by the power of a brook a mile away. We are informed that in the daytime wires from this first dynamo are coupled up to another near the house, which is used to drive a sawing-machine and to do other work. This arrangement may be regarded as a model of the way in which our electrical engineers promise in the future to furnish us with light, heat, and motive power. The great idea is to generate a current at some fixed station where power can be had cheaply, or for nothing, as in the case of a large waterfall; then, by means of turbines or water-wheels, the power can be made to drive a dynamo machine, which, united to a distant one by wires, will, allowing for a certain amount of loss, bring to our homes the force of the far-off torrent.

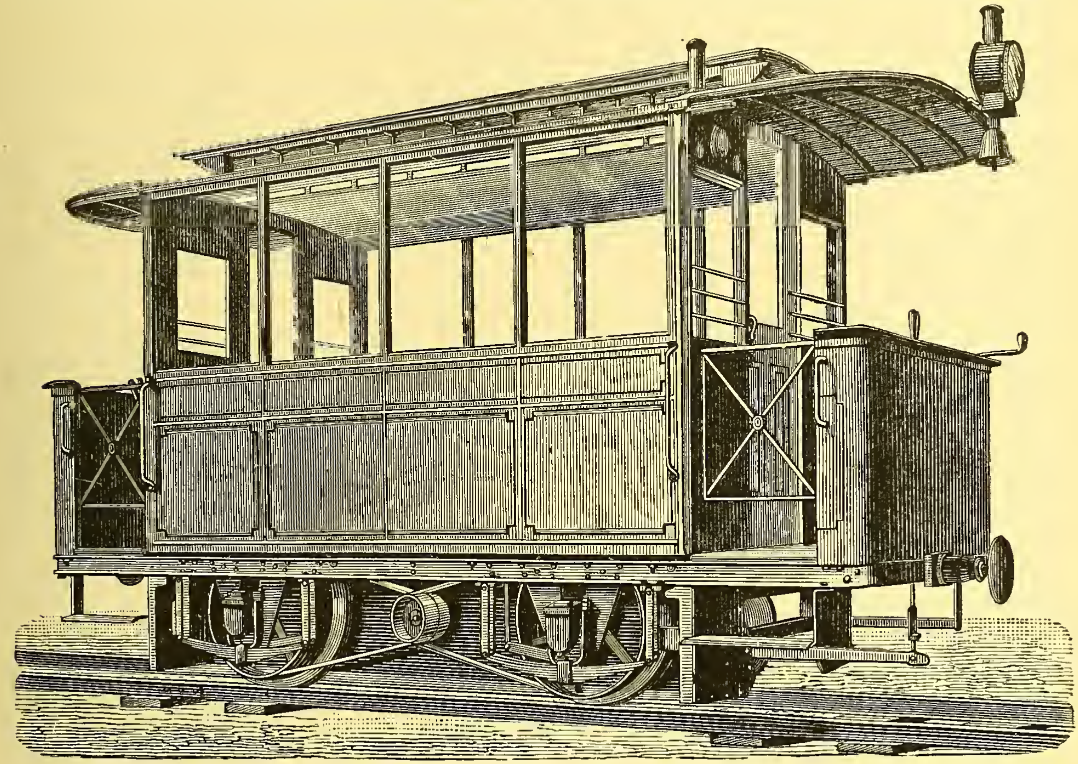


Fig. 3.—ELECTRIC RAILWAY-CARRIAGE, 1882.

At the Electrical Exhibition which was held at Munich in 1882, this latest application of the dynamo machine was shown in a complete manner, and upon a scale sufficiently large to prove its practicability and value. At Hirschaw, which is three and a half miles from the exhibition buildings, there is a locomotive factory at which water-power is largely employed by means of turbines. One of these was utilised to turn a dynamo machine, the current from which was conveyed by thin copper wires to the exhibition. Here, in the daytime, it was made to work electric ploughs and other novel agricultural appliances, and at night the current served to supply thirteen powerful arc lamps. It was estimated that the resistance of the wires caused a loss in transit of about one-eighth of the current generated. A still more interesting experiment was made at the same time and place by M. Deprez, for the circuit he employed covered thirty-five and a half miles, and utilised the ordinary iron telegraph-lines between Munich and Miesbach. The motor employed at the distant station was a steam-engine, whose energy was conveyed electrically to Munich, where it pumped water.

Without attempting any complicated description, it can now be readily understood how a dynamo machine may be made to actuate the wheels of a locomotive, if by any means the current from a stationary dynamo can be conveyed to it. The metallic rails offer a ready means of doing this, and, in practice, one rail may be made to convey the current through the travelling dynamo, whilst the other one serves to complete the circuit with the stationary machine. This plan was adopted in the first electric railway made by Messrs. Siemens and Halske for the Berlin Exhibition of 1879 (see Fig. 2). This railway, although but a toy (for it consisted only of a circular tramway fifty yards in diameter, while its gauge was only about two and a half feet, and its carriages were mere seats to hold eighteen passengers) clearly demonstrated the possibility of locomotion by electricity. The same firm were soon busy upon another railway three kilomètres long, and one of the carriages made for this service was exhibited at the Electrical Exhibition in Paris (see Fig. 3). At this exhibition of 1882 a railway also was shown in operation, but Messrs. Siemens were obliged to convey the current, not by the rails, but by making connection with a wire running by the side of the track. This modification was to prevent any accident through horses crossing the rails, and getting thereby an injurious discharge of electricity through their bodies.

Of Mr. Edison's experimental railway at Menlo Park little is known, but from the only short account accessible we learn that the total weight of the engine is four tons, and that the railway is three miles in length. Mr. Edison estimates that a central station will be required on this description of railway for every ten miles of track, to furnish energy for five miles on either side. He believes that the system will be found far more economical than propulsion by steam. Now it is quite evident that this cannot be, if steam is used to move the stationary generator of the current. It would be far better to use the steam in an ordinary locomotive. But where water-power can be utilised, Mr. Edison's figures may possibly be borne out. We shall have an early opportunity of testing the matter near at home, for an electrical railway is now being laid between Portrush and the Giant's Causeway in the North of Ireland. This novel line is seven miles in length, and the power for it is to be derived from the waterfalls which abound in its neighbourhood. The current is to be conveyed by an overhead wire, for Messrs. Siemens, whose machines are to be used, consider this the best way of applying it, but the return current will pass through the rails and earth. We may look upon this railway as a test by which we can really gauge the success obtainable by the electric railway system. Of its mechanical success we may feel quite sure, but whether it can be made to pay is a question that can only be answered by actual experience of its working.

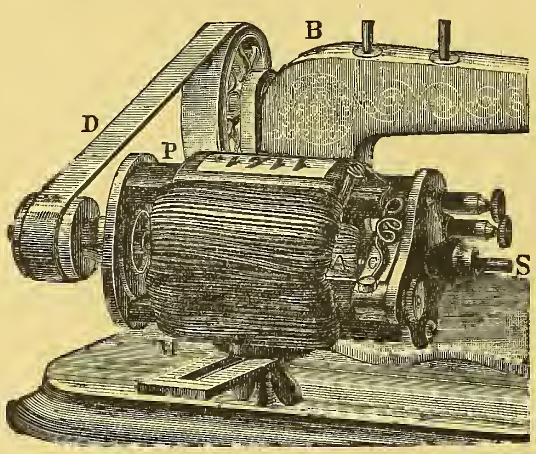


Fig. 4.—THE GRISCOM MOTOR.

A wonderfully perfect little machine is presented in the "Griscom motor," illustrated in Fig. 4. It measures only a few inches in length, and is intended to work sewing-machines, or for any purpose where exceedingly light work is required. It is actuated by a simple form of battery which does not lead to much trouble or expense. S is the spindle bearing the rotating armature, at the other extremity of which is a wheel to carry the belt, D, over the wheel of the sewing-machine, B. P is the outer framework constituting the field magnets, A the armature, and M a clamp for readily attaching the whole arrangement to the sewing-machine. We may assume that any one using the Griscom motor will look forward to the time when electric energy will be supplied, as promised, from house to house. Then the battery can be dispensed with, and the little machine can be run from the household supply.

THE GIANT CENTIPEDE (*Scolopendra gigantea*) OF INDIA. (*Natural size.*)

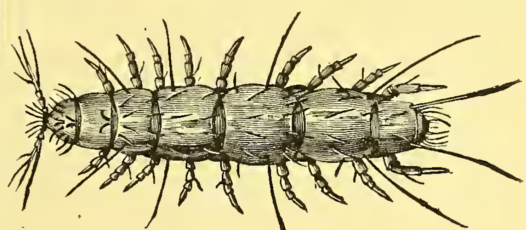
The reversal of the dynamo electric machine opens out a vista of magnificent possibilities, the full extent of which it is very difficult at first sight to grasp. Transmission of energy is not possible by steam alone, because of the rapid condensation which must occur if any length of piping is employed. The hydraulic system permits us to convey energy from a central engine to numerous points in a certain area around it, and such a system is seen at work in great perfection at our numerous docks. Compressed air will also convey energy to a certain distance, but in both cases pipes are required, and such pipes for hydraulic use must be constructed to resist a very high internal pressure. One of the greatest advantages of using electricity is that the links of communication are simply wires. We have seen how much has been done experimentally, and there is little doubt that in a short time the system will have stepped out of the experimental stage on to the arena of practical employment.

A GIANT CENTIPEDE.

WITH the appearance of the ordinary centipedes, most, if not all, readers are very familiar. The names "hundred feet," "gally-worms," and the like, applied to the centipedes and their neighbours, clearly show the public appreciation of characters upon which the zoologist also relies for his distinction of the class from its neighbours. Centipedes, in one sense, may be described as worm-aristocrats. They possess the long jointed body of the worm, and want that massing together of parts and segments, to form chest and abdomen, which we see in insects, and, in a certain modified state, in spiders and lobsters as well. Then the numerous legs appear to our common observation as a character of importance. There may be over 200 rings, or joints, and well nigh as many feet, in some members of this class ; and the striking similarity of the segments and legs forms one of the most salient features of these animals. They mostly have ocelli, or single eyes, not the composite eyes of many insects.

The specimen depicted in our full-page illustration is the *Scolopendra gigantea*, or Giant Centipede, of India. It is depicted of the natural size, and it will thus be seen that it attains a length of nine inches, or even a foot. The true centipedes seem to possess from twenty-one to twenty-three joints, each bearing a pair of legs. There are very few of the *ocelli*, or simple eyes, developed in this group, this character contrasting with the appearance of the huge eye-masses that decorate the head of most insects. In the structure of the centipedes there are many points of interest. They are known, for example, to be poisonous, and the bite of the Giant Centipede is deservedly feared. The "mouth" of the centipede, like that of the insect, is represented by certain paired appendages. There is, firstly, the "mandibles," or large jaws, a lower lip, or "labium," and two pairs of "foot-jaws." It is the second pair of these foot-jaws which form the poison-apparatus. They possess each a hooked fang, and this fang, in turn, is hollow, and leads by a canal to the poison-gland, which is situated within the body of the animal. When the prey is hunted, the poison-fang being plunged into its body, the attacked animal is rapidly paralysed, and finally overpowered.

In habits the centipedes are carnivorous. They attack insects and allied forms, and live amongst damp moss, under stones, amidst decaying vegetation, and in like situations. Curiously enough, this group of animals includes representatives of very minute size, in addition to the giant form figured



PAUROPUS.

in our illustration. The little *Pauropus*, discovered by Sir John Lubbock, attains a length of only about $\frac{1}{20}$th of an inch. There are only nine pairs of legs in this little form, which is of a white colour, and lives amongst decaying leaves. There is hardly any feature in common, apparent to the unscientific eye, between the minute form as above figured, and the great tropical centipede ; yet scientific investigation proves their close relationship, and shows the two forms to be merely modifications of one great type.

AN EXTRAORDINARY BEDSTEAD.

IN February, 1883, there was exhibited for a time in Paris, an extraordinary bedstead of rare costliness if not of rare value, made for an Indian prince. The cost of its construction was between four and five thousand pounds. The canopy was supported by four elegant and beautiful automaton female figures costumed in the national dresses of Spain, Italy, France, and ancient Greece ; they waved fans to cool the air, and their eyes moved. The mattress was a huge musical box, which began to play a series of operatic airs directly any one lay upon it. To add to the apparent reality of the moving figures, they wore wigs. With us, however, bedsteads are intended to be slept upon ; and it is not very clear how moving figures around and operatic music underneath would conduce to that object.

FROST EXPLOSIONS.

The modern householder knows, to his cost, the difficulty of keeping his water-pipes from freezing when the winter temperature hovers between zero and 32° Fahrenheit. There is not only the inconvenience to contend with of being without water, but the far more serious one of having the pipes fractured by the cold—an accident often not suspected until a thaw sets in—when the liberated water pours in gallons from the broken pipes, and carries destruction in its path. Let us try and answer the question why cold should have the strange effect of tearing asunder the thick lead or iron piping by which water is conveyed into our dwelling-houses.

It has been shown in a previous article (p. 15) that water is somewhat exceptional in its behaviour when exposed to different changes of temperature. Many bodies, in passing from the liquid to the solid state, undergo a diminution of volume; in other words, they shrink. But water (with some few other bodies) expands. In the form of ice, its volume is much greater than before. For this reason ice floats on the surface of water, being lighter, bulk for bulk, than the liquid medium around it. It is this final expansion, and the enormous pressure exerted by it when confined in closed receptacles, which causes our water-pipes to burst in the winter-time if they be not properly protected from the frost. A strong wrought-iron tube filled with water, and closed with a screw stopper, will, if exposed to sufficient cold, explode with a loud report; and this means of demonstrating the force of ice expansion is frequently adopted in the lecture-room.

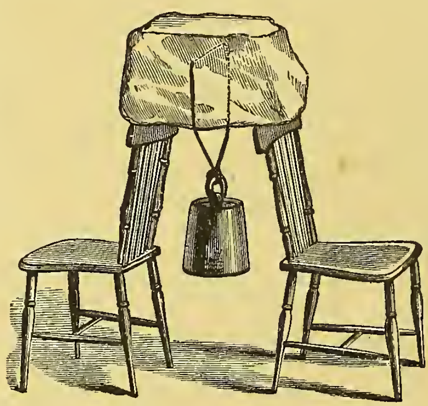


Fig. 1.—PRESSURE MELTING ICE.

Another point must be noticed, and it is this: the melting-point of ice can be considerably lowered by pressure. It has been proved by special apparatus that water can be kept liquid at a temperature below zero. But without any complicated arrangements it can easily be shown, experimentally, that pressure does exert a liquefying action. If a large block of ice be supported at each end, so that its middle can be embraced by a thin wire, to which is attached below a heavy weight, the wire, by reason of the pressure which it exerts, will gradually melt the ice below it until it cuts its way through, and the weight falls to the ground. If the experiment has been conducted as it should be — out of doors, in a temperature below the freezing-point — the two halves of the block will re-unite, and will show no sign that they have ever been separated. We shall now be in a position to understand the bearing of some very interesting experiments carried out to show the disruptive power of water in the act of assuming the solid state.

The first experiment of the kind was tried some years ago by Major Williams at Quebec, where, as we need hardly remind the reader, the winter frost is of exceptional severity. A 12-inch spherical cast-iron shell was filled with water, and confined by driving into the aperture intended for the fuse a wooden stopper. He could hardly have chosen a more effective cork, for the moisture, rising into the pores of the wood, caused it to swell until it was too tight to be withdrawn by any ordinary means. The shell, with this novel charge, was then exposed to the winter air, and although not filled with an explosive, in the usual sense of the word, it ultimately gave a sharp report, and its wooden bung was projected to a distance of 100 yards, just as if it had been fired from a musket. At the same time, a cylinder of ice about 8 inches in length was forced from the orifice. Another experiment was still more striking, for the wooden stopper, on this occasion, remained in its place, but the shell split into two halves, and a sheet of ice was squeezed out of the fracture, forming a kind of ledge all round the middle of the sphere.

During the severe winter of 1879-80, these experiments were repeated by M. Hagenbach—one of the professors of the University of Bâle—and the curious effects produced were carefully noticed. The two shells experimented upon were subsequently photographed, and our illustration is an exact reproduction of the pictures so obtained. In the first case, a shell was filled with water, its opening being closed, not with a wooden plug, but with an iron stopper, which was *screwed* into it. It was exposed all night to a temperature of 10° Fahrenheit, and was found in the morning presenting the appearance shown at A and B, views taken of the same object from different points. At C and D we see the results obtained from the exposure of a second shell to a temperature of about the same severity. It was placed in the open air at 10 o'clock in the morning, and exploded at 9 o'clock. The same evening. It will at once be noticed that the two shells, A B and C D, present some peculiarities which, at first, are difficult to comprehend. In the first case, the screwed iron stopper has remained in its place, but the shell has been fractured in such a way that a triangular piece has been forced away, which is held to the shell by a mass of extruded ice. It will also be noticed that a bent needle of ice is attached to the main mass. The most probable explanation of the appearance is as follows:—The shell being entirely filled, the water within it had no room for expansion. No ice was formed immediately, but the pressure exerted was sufficient to affect the iron envelope, which, by reason of its elasticity, would, to a certain extent, "give." This action caused a small leakage through the thread of the screw stopper, and a thin jet of water was forced out there. Being released from pressure this jet instantly froze, and in doing so fell over upon, and took the same contour as, the outer surface of the shell. The shell itself was then ruptured as shown in the photograph, the curved filament of ice being raised with the fractured part, and remaining attached to it.

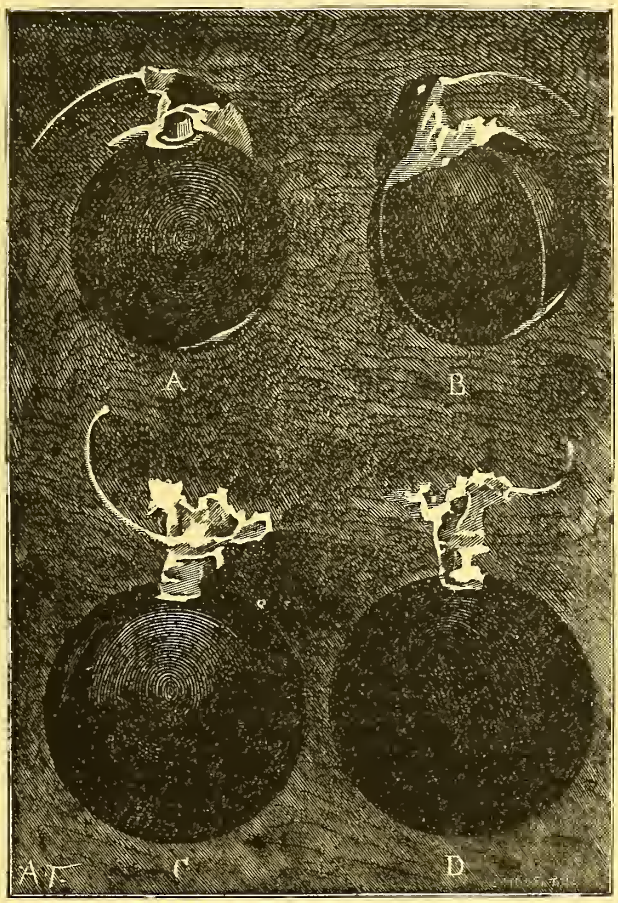


Fig. 2.—EXPLOSIONS BY CONGELATION.

In the case of the other shell, C D, the pressure from within also caused the thread of the screw to gape, and a liquid jet was forced out, continuing, as it were, the spiral path of the screw thread outside the shell. This immediately froze, and retained its shape. When the actual explosion occurred, the stopper was so violently ejected from the opening that its final resting-place was never discovered. At the same time, the threaded opening of the shell was completely torn away, and several fissures radiated in every direction from it. As in the old experiment at Quebec, a column of ice was extruded from the opening, in this case crowned by the spiral jet which at first escaped. It may be assumed that in each case congelation was almost instantaneous, occupying but the fraction of a second of time.

If such effects can be produced on metallic vessels of exceptional thickness and strength, we can easily understand how those minor effects can happen which cause us such inconvenience in winter-time. The water in our household pipes congeals with the first frost of winter if those pipes are in an exposed and unprotected situation, and with that congelation there comes expansion and consequent pressure from within, which the toughest metal cannot withstand. But we can also read from these experiments a lesson of wider import. We can learn that the force of gunpowder and dynamite in tearing rocks asunder is nothing to the force which, in nature, accomplishes the same purpose on an enormous scale. Fissures in rocks, which can hold individually but small quantities of rain-water, may become, when that water has turned into ice, the first elements of a gigantic land-slip. We could not better illustrate the feebleness of man's greatest efforts when contrasted with the forces of nature.

FEATS OF ARCHERY.

THAT most ancient of hunting and warlike implements—the bow—although it is now only used for amusement, has played a very mighty part in the history of the world. In all ages feats performed with it of the most wonderful description are on record. Sir John Smith spoke of the bow as a gift from God to the English nation, to make it singularly powerful in war; and Bishop Latimer also said of it, in one of his sermons, "it is a gyft of God, that he hath geven us to excell all other nacions wythall." Carew wrote upbraidingly of the neglect of archery in his day, and giving the bow words, makes it say :—

"As in fight I give you protection, so in peace I supply your pastime, and, both in warre and peace, to your lymmes I yielde active plyantnesse, and to your bodies healthful exercise ; yea, I provide you food when you are hungrie, and helpe digestion when you are full. Whence then proceedeth this unkind and unusual strangeness ? Am I heavy for burden? Forsooth, a few light sticks of woode! Am I cumbrous for carriage? I canch a part of myself close under your girdle, and the other part serveth for a walking staffe in your hand! Am I unhandsome in your sight? Every piece of me is comely, and the whole keepeth a harmonical proportion. Lastly, am I costly to be provided? or hard to be maintained? No! Cheapness is my purveyor, easiness my preserver."

Passing from this eloquent old tribute to the virtues of the bow, let us note briefly a few of its wonders.

Some marvellous feats are said to have been performed by the Cretan archers whom the ancient Greeks employed. Xenophon tells of a man whose head an arrow passed quite through. The Persians, who boasted their descent from the famous hero archer Perses, and the Scythians, descendants of the great archer Scythes, were among the most skilful archers of the ancient world. It is recorded that the ancient Persians could drive one arrow out of the hole it made, with another, at a long range, and repeat the feat with several successive arrows, when practising at their sand butts. We read also that they shot from horseback, hitting a mark on a post while galloping. One archer would gallop past a butt at full speed and send two arrows through one hole while doing so. Homer tells how Penelope promised her many suitors that he only should be favoured

> "Who first Ulysses' wondrous bow shall bend,
> And through twelve ringlets the fleet arrow send."

well knowing that only her husband could display such power, in proof of which, when they failed he re-won his wife, for, bending his bow,

> "The whizzing arrow vanished from the string,
> Sung on direct, and threaded every ring."

Although the Roman legions discarded the bow in war, trusting entirely to the charge and hand-to-hand fighting, feats of archery were displayed in the circus, and many of the Roman emperors were famous archers. It is said that Domitian would place boys in the circus at a considerable distance from him, and, as they held up their hands with their fingers outspread, would send his arrows between them with such nicety and accuracy of aim, that he never inflicted a wound. Commodus boasted that he never missed his aim or failed to kill the wild beast he exercised his skill upon, each with a single shaft, striking exactly where he had announced his intention of striking. He would set an arrow in his bow as some wild beast was set free in the circus to devour a living criminal condemned to die, and just when the furious and hungry beast was springing upon its prey, would lay it dead at the criminal's feet. Sometimes one hundred lions were let loose at once, in order that he, with a hundred arrows, might kill them all. With arrows, the heads of which were semicircular, he would sever the necks of ostriches while they were in flight. Remembering the small neck and swiftness of the ostrich makes this feat appear the more astonishing.

It is said that an archer, named Aster, seeing Philip of Macedon among his troops, wrote upon an arrow, with which he hit him in the eye, "Aster sends Philip a deadly shaft." Zosimus mentions an archer named Menalus, who could discharge three arrows at once and hit each of three objects he aimed at. He fell at last by the hand of a general named Romulus, in the army of Magentius, whom he had previously shot at and wounded.

Chardian, speaking of the Persian archers, says they practised at a mark placed on the top of a mast twenty-six feet from the ground. Towards this the horsemen rode, with bent bow, at full speed, and in passing the mark turned and shot at it backwards, sometimes to the right, sometimes to the left, seldom missing. Mr. Tavernier, who witnessed a review of Persian troops in 1654, describes a soldier on horseback who "drew two arrows from his quiver, and, holding one between his belt, fitted the other to his bow ; then forcing his horse vigorously across the plain till he passed the butt, he, in the Parthian manner, drove an arrow into the centre of the target ; turning about he, in the same manner, shot his second arrow precisely into the hole from which his first arrow had been drawn." The Persian bow required a pull of five hundred pounds.

The Turks are said to have been at one time very skilful archers. An old traveller says that they practised regularly with the bow from seven or eight years old, and upwards, to manhood. It was a common feat for them to shoot several arrows from the distance of ten yards into a mark not larger than a die. Lord Bacon said of the Turkish bow, "it giveth a very forcible shoot, insomuch as it hath been known that the arrow hath pierced a steel target or a piece of brass of two inches thick." In July, 1792, Mahmood Effendi, secretary to the Turkish Embassy at London, shot an arrow four hundred and fifteen yards partly against the wind, and four hundred and eighty yards with the wind. He did this publicly in the grounds adjoining Bedford House. In 1798 the Sultan of Turkey shot an arrow nine hundred and seventy-two yards, a feat scarcely surpassed by those attributed to Robin Hood. That famous outlaw's existence is vouched for by such a mass of traditionary evidence, all of which is so strongly supported by local and archæological evidence, that it is almost as difficult to understand why it has been denied, as it is to see a reason why Shakespeare's plays should be attributed to Lord Bacon.

Giraldus Cambrensis, speaking of the ancient Britons of Wales as famous for their dexterity with the bow in the time of our second Henry, says "There is a particular tribe in Wales named the Venta; a people brave and warlike, and who far excel the other inhabitants of that country in the practice of archery. During a siege it happened that two soldiers, running in haste towards a tower situated at a little distance from them, were attacked with a number of arrows from the Welsh, which, being shot with prodigious violence, some penetrated the oak doors of a portal, although they were the breadth of four fingers in thickness. The heads of the arrows were afterwards driven out, and preserved in order to continue the remembrance of such extraordinary shooting with the bow. It happened also in a battle, at the time of William de Brusa, as he himself relates, that a Welshman having directed his arrow at a horse-soldier, who was clad in armour, and had under it his leather coat, the arrow pierced through the man's hip and also struck through the saddle, and mortally wounded the horse on which he sat. Another Welsh soldier, having shot an arrow at a horseman who was protected by stout armour in the same way, the shaft penetrated through his hip and fixed in the saddle; but what is most remarkable is, that as the horseman drew his bridle to turn round, he received another arrow in his hip on the opposite side, which also passing through, he was firmly fastened to the saddle on both sides."

In the memorable battle between the English and Scotch near Halidowne (or Halidone) Hill, in 1402, the arrows of the English archers were so strong and propelled with such terrible strength that no armour could repel them, they "ranne through the men at arms, bored the helmets, pierced their very swords, beat their lances to the earth, and easily shot those who were more slightly armed through and through," says an old historian.

Philip de Comines confessed that the English archers in his day excelled those of all other nations; and Sir John Fortescue wrote, "The might of the realme of England standyth upon archers." The first Emperor Napoleon said that the old English archers were the best light infantry of their day. Each could discharge twelve arrows per minute, and send them from a distance of two hundred yards quite through oaken planks varying in thickness from an inch and a half to two inches. At the battle of Creçy it was found impossible to get horses to face the deadly arrows of the English archers.

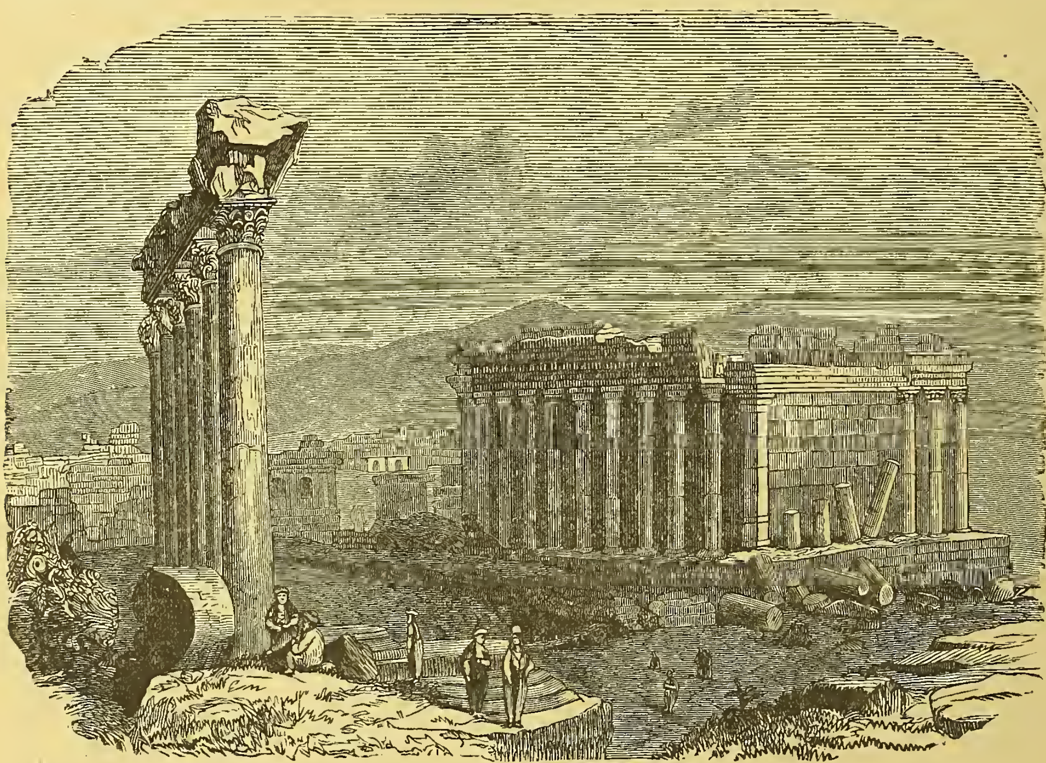
The feat of William Tell in shooting an apple from the head of his son may be found related of many other old-world heroes, as well as of the famous William of Cloudesley, who could split a hazel wand with his shaft from a distance of two hundred yards. In the time of Henry VIII. a curious archery feat was performed by a man who was called from it ever after by the nickname of "Foot-in-bosom." He shot "a very good shot" with one foot in his bosom. Mr. Barrington records in the "Archæologia," a tradition of an attorney at Wigan, in Lancashire, named Leigh, who shot an arrow a mile in three flights. It is reported that he sat on a stool and had the centre of his bow fastened to one of his feet, that he thus elevated his bow to an angle of five-and-forty degrees and pulled the string with both hands. It is on record that the Arabians performed simple feats of archery in this way with the hands and one foot. Arrian chronicled the fact that Indian archers used their left feet in the same way; and the same fact is recorded of Ethiopian bowmen by Diodorus Siculus and Strabo. The latter also tells us, that when shooting elephants these archers employed bows which required the strength of three persons to shoot with them; two to support the bow by the aid of their feet, and a third to place the arrow and pull the string. Xenophon, speaking of the Carducians, wrote, "They had bows which were three cubits long, and arrows of two cubits. When they made use of these weapons they placed the left foot on the bottom of the bow, and by that method drove their arrows with great violence, piercing through the shields and corselets of his men."

In 1801 Mr. Roberts says he knew archers who could put twenty arrows successively into a four-foot target at one hundred yards, shooting at each end; twelve arrows within the compass of two feet at forty-six yards; ten successive arrows in an eight-inch paper at thirty yards; fifty-two arrows out of a hundred into a four-foot target at one hundred yards; and two successive arrows into an eight-inch paper at one hundred and twenty yards. One of the Royal Scottish Archers could plant three arrows in a circle of four inches diameter.

It will give some idea of the extraordinary skill, combined with strength, requisite to a proper use of the bow, if we mention, in concluding, that the famous modern Hercules, Topham, sneering at the long bow as a weapon of a child, in the presence of the Finsbury Archers after they had gone through their customary exercise at Finsbury, one wagered a bowl of punch that he, Topham, would not be able to draw his (the archer's) bow two-thirds of its length. Topham accepted the bet with a scornful laugh, tried, and to his great mortification failed.

A MYSTERIOUS CITY.

AMONG the grandest relics of a great nation's vanished glory stands the ruins of Baalbec, or Heliopolis, both names having the same meaning, which is the City of the Sun. Its history is lost in the thick obscurity of a very remote past, and even its existence was for centuries utterly unknown. The extraordinary silence of the ancient Greek and Roman writers concerning a place so extensive, wealthy, important, and magnificent is unaccountable. marble doors of prodigious dimensions, windows and niches bordered with exquisite sculpture, and the fragments of beautiful arches, cornices, capitals, and entablatures, says: "The master-works of art, the wrecks of ages, lay scattered as thickly as the grains of dust beneath our feet. All was mystery, confusion, inextricable wonder. No sooner had we cast an admiring glance on one side than some new prodigy attracted us on the other. . . . Time carries his secrets away with him, and leaves his enigmas as sports for human knowledge!"



GREAT TEMPLE AND SIX COLUMNS AT BAALBEC.

John of Antioch is the only ancient author by whom it is mentioned. He says: "Alius Antoninus Pius built a great temple at Heliopolis, near Libanus, in Phœnicia, which was one of the wonders of the world." Oriental writers, speaking of it at the period of the first Arab invasion, describe it as being then one of the most splendid of Syrian cities, having stately palaces adorned with monuments of great antiquity, abounding with fountains and artistic adornments of wonderful richness, variety, and beauty. Buckingham, speaking of the remains of its great temple, in which the sun was worshipped, says: "I should conceive that in no country was to be found so superb a monument of the inimitable perfection of ancient architecture." Lamartine, wrapt in wonder as he surveyed the

Another modern traveller writes: "So little is known of the ancient Baalbec, that it seems more like one of those cities of the 'Arabian Nights' than a place for centuries of actual wealth, importance, and luxury. Perhaps it is best that it should be thus, as if it were destined that the noble ruins should alone tell the tale. Could any other story be so interesting, any other monument of the dead so grandly impressive?"

Baalbec stands on the road between Tyre and Palmyra. Seen from a distance as you descend the last slope of the Anti-Lebanon, past the quarries, it is not impressive. On the green expanse at the mountain foot you trace six columns upon a square block of masonry amidst fallen walls. But when you stand amongst the Titanic ruins, and gaze with amazement on the torsos of the piled-up columns at the feet of those still standing a hundred feet or more above you, faultless in their proportions and majestic in their marvellous beauty, how different are your feelings! Bayard Taylor says: "I know of nothing so beautiful in all remains of ancient art as these six columns, except the colonnade of the Memnonium at Thebes, which is of much smaller proportions. From every position, and with all lights of day or night, they are equally perfect."

The ruins of Baalbec do not now cover any large extent of land: we have, indeed, only the ruins of three distinct edifices standing, a little distance apart, the most remarkable of which occupies a circuit of more than half a mile. It consisted originally of a portico, an hexagonal court, and a quadrangle, with the peristyles, six Titanic highly polished pillars of pale yellow stone, with their cornice and entablature, each formed with but two or three vast blocks, fitted together with such marvellous precision that the junction-lines are invisible, and without cement or mortar.

Maundrell, speaking of the temple, and of the wall encompassing it, made with stones so monstrously huge that the natives attributed its building to Satanic influence, says: "Another curiosity of this place which a man need be well assured of his credit before he ventures to relate, lest he should be thought to strain the privilege of his credit too far, That which I mean, is the large piece of an old wall." Three of the stones of this wall he measured, and says: "We found them to extend sixty-one yards in length; one twenty-one, and the other two each twenty yards, and in breadth of the same dimensions. These three stones lay in one and the same row to the end. . . . That which added to the wonder was that these stones were lifted up into the wall more than twenty feet from the ground."

IMMENSE STONE AT BAALBEC.

At the bottom of one of the quarries already mentioned a single stone was found (shown in our second illustration), seventy feet long, fourteen broad, and in thickness fourteen feet six inches! Its weight must have been more than one thousand one hundred and thirty tons, and it has been calculated that to raise it would require the strength of sixty thousand men! The stones at Baalbec are indeed *the largest that have ever been moved by human power!* and how they were so closely fitted and conveyed to their places is to this day an insoluble mystery. It is not too much to say that the task would be impracticable even in these modern engineering days. The difficulty faces us in relation to many of the immense stones in the buildings of antiquity; but in this case every conjecture as to the mechanical means employed is fairly baffled. They are cut with faultless precision, and so closely joined that the finest needle could not be forced between them! On this point M. Lamartine says: "When it is considered that some of these blocks of hewn granite are raised one above another, to the height of twenty or thirty feet from the ground, that they have been brought from distant quarries, and raised to so vast a height to form the pavement of the temple, the mind is overwhelmed by the mere idea. The science of modern times cannot help us to explain it, and we cannot be surprised, therefore, that it should be referred to the supernatural."

When Dawkins and Wood visited Baalbec, nine columns of the large temple were erect. In 1784 Volney found but six. There were originally thirty-four belonging to the smaller temple, now there are but twenty. The granite of which they are formed exists nowhere near them, and where it could have been obtained is unknown.

The interior of the chief temple, with its fine Corinthian pilasters, is full of masterpieces of Grecian sculpture. The platform of vast stones on which it stands is a thousand feet in length, and averages twenty feet in height. In the village is a small circular Corinthian temple, of great elegance and beauty, about thirty feet in diameter, built, as has been supposed, for a tomb.

After the capture of Damascus, Baalbec was invested by the Moslems, and, after a long and brave resistance, was captured. Its commercial importance was shown by the fact that during the siege its enemies captured a caravan bearing four hundred loads of silk, sugar, and other commodities; and its wealth by the ransom that was exacted, of two thousand ounces of gold, four thousand of silver, two thousand silk vests, and a thousand swords, in addition to the arms borne by its defenders.

In 748 it was sacked and dismantled by the Khalif of Damascus, and its chief inhabitants slaughtered. In 1400 Timour the Tartar captured and plundered it; and it afterwards fell into the hands of the predatory Mootualies.

THE OLD DAYS OF TAXATION.

An eminent statesman and famous law lord gave about fifty years ago as the most astonishing proof extant of John Bull's power of endurance, the following list of taxes in a time of war:—"Every article which enters into the mouth, or covers the back, or is placed under the foot, has its tax. Taxes are on everything which it is pleasant to see, hear, feel, smell, or taste: we have taxes upon warmth, light, and locomotion; on everything on earth, and the waters under the earth; on everything that comes from abroad, or is grown at home; taxes on raw material; taxes on every fresh value that is added to it by the industry of man; taxes on every source which pampers man's appetite, and the drug that restores him to health; on the ermine which decorates the judge, and the rope which hangs the criminal; on the poor man's salt, and the rich man's spice; on the brass nails of the coffin, and the ribbons of the bride; at bed or at board, couchant or levant, we must pay. The schoolboy whips his taxed top; the beardless youth manages his taxed horse with a taxed bridle upon a taxed road, and the dying Englishman pouring his medicine, which has paid seven per cent. in tax, flings himself back upon his chintz bed, which has paid twenty-two per cent., makes his will on an eight pound stamp, and expires in the arms of an apothecary who has paid licences of £100 for the privilege of putting him to death. His whole property is then immediately taxed from two to ten per cent. Besides the probate, large fees are demanded for bringing him in the chancel, his virtues are handed down to posterity on taxed marble, and he is at last gathered to his fathers and taxed no more."

INSTANTANEOUS PHOTOGRAPHY.

As indicated in a former article dealing with the history of photography, the so-called gelatine process is so quick in its action that objects moving with the greatest speed can be secured as pictures by its help. Indeed, it was found that an image could be obtained in such a small fraction of time that mechanical appliances for opening and shutting the lens aperture with extreme celerity must be employed, since no unaided hand could accomplish the movement quickly enough.

Shutters are most varied in form and manner of working. Some are simple, some most elaborate; and like many other mechanical contrivances, the simple ones are the best in actual use. A description of one of these, known as the drop shutter, will be quite sufficient to indicate the purpose of all. A piece of mahogany, about three inches by ten, and half an inch thick, has a hole—the exact size of the outer rim of the camera lens—bored near its centre. In front of this board are fastened on either side, so as to face one another, two grooved pieces of wood. In these grooves slides another board, or ebonite plate, also with a hole in it of the same size as the other. A trigger, or catch of some kind, holds the ebonite board in its place, and when released it drops in its groove. As its aperture passes the lens, the sensitive plate is, for about the fifteenth part of a second, exposed to the action of the light, and a picture is taken. For objects in quick motion the drop shutter is too slow, unless furnished with an india-rubber loop, fitting upon a stud in the sliding-screen. When this elastic loop is stretched the shutter is ready for action, and it pulls the screen across the lens, opening with a speed represented by the two-hundredth part of a second. The quickness with which a photograph can be taken may be noted by simple expedients. For instance, a tuning-fork, giving so many vibrations in a second, may be made to trace these vibrations on the falling shutter itself. A more easily understood method is to employ a dial, round which a hand revolves in one second of time. If this moving object be photographed, as a test of speed, the resulting picture will show, by a shadowy outline, how many degrees of this circle is covered by the image of the pointer. Photographs of the sun have been taken in the twenty-thousandth part of a second.

Fig. 1.—USING THE PHOTOGRAPHIC GUN.

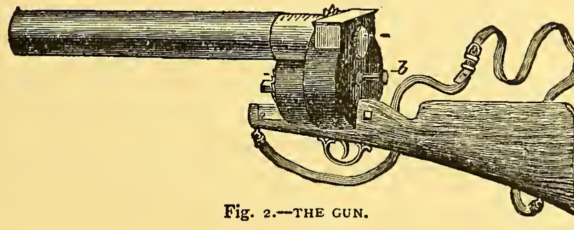


Fig. 2.—THE GUN.

The new power thus placed in the hands of the photographer was quickly taken advantage of.

Mr. Bolas, of the Chemical Society, must be credited with the invention of a most ingenious form of apparatus designed for police use, and called the detective camera. Its design is to take portraits of suspected characters without their knowledge, so that if a constable observes a loiterer of suspicious aspect in the streets, he can secure the man's portrait as a means of future identification. The camera, in outward appearance, is no camera at all. It is made to look like a basket, a portmanteau, or a shoeblack's box, according to the taste of the operator. But whatever the outward form of disguise, inside it contains the means of taking a most rapid photograph of any person or object opposite whom it may be for a moment placed. The results obtained by such an apparatus are far more valuable than if gained in an ordinary studio, where the model is fully alive to what is going forward. In the one case he looks as he is, and in the other he is trying to look like his own ideal of himself. We have seen results produced by the detective camera which show that it is no toy, but an efficient piece of apparatus.

Another outcome of rapid photographic plates is an opera-glass, fitted up like a camera, which can be taken out of doors, held against the breast for the sake of steadiness, while a picture of the size of a penny-piece is secured by touching a trigger. One barrel of the glass is fitted at its larger end with a ground-glass screen, upon which the object of attack is focussed. The other barrel contains the sensitive plate and instantaneous shutter. The perfection of detail secured by this "opera-glass" is marvellous. We have before us a photograph taken by its aid, in which a life-guard is represented on duty in Whitehall. Standing by his horse's head is a policeman, whose figure barely measures half an inch in height. Yet, by means of a magnifying-glass the letter and number on that policeman's collar can be plainly read.

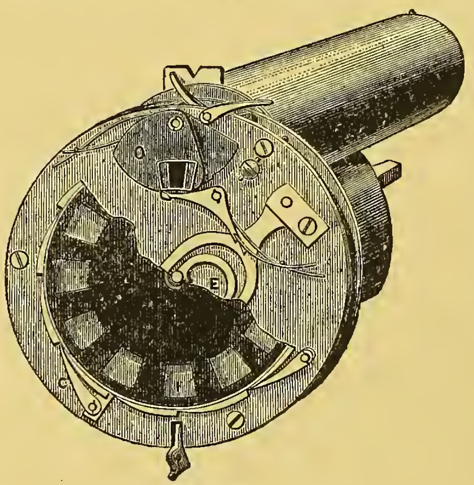


Fig. 3.—CHAMBER OF THE GUN.

Professor Janssen has contrived a species of photographic revolver, with which he has been able to secure instantaneous pictures of the sun and other heavenly bodies. This instrument was used during the last transit of Venus. On a somewhat similar plan Mr. E. J. Marey has constructed a photographic gun, with which to obtain pictures of a bird's flight. The study of animal mechanics has of late years been pursued with great ability; and such pictures as can be obtained by this apparatus must help forward such a study in a remarkable degree. The general form and manner of using the photographic gun are shown in Fig. 1, but its various parts are detailed in Figs. 2 and 3. The barrel may be compared to the brass tube which projects from the front of an ordinary camera; its duty is merely to hold the lens, and it can be lengthened or shortened like a telescope, so as to focus the image. At the rear end of the barrel is a large and clumsy-looking breech-piece, which contains the circular sensitive plate, and the necessary mechanism for rotating it as it receives twelve pictures in one second of time. The motive power is clockwork which, on pressure of the trigger of the gun, causes a central axis to rotate twelve times in a second. There are two discs which revolve on this axis: first, an opaque one, with a slit in it, whose duty it is to let a streak of light through the lens on to the sensitive plate at every revolution; and secondly, a disc pierced with twelve openings (see Fig. 3), against the velvet surface of which is tightly pressed, by means of a spring button (*b*, Fig. 2), the sensitive plate. At every revolution of the first disc the second one offers one of its twelve apertures to the lens. Thus, in one second of time, a bird on the wing is photographed twelve times, each picture giving a different *pose*.

Fig. 4.—UP-WING STROKE.

Fig. 5.—DOWN STROKE.

As may be imagined, the pictures are extremely small; but this is not a point of much moment in photography, for the detail is so good that they can be enlarged many diameters without suffering any loss of sharpness. Mr. Marey has examined some of these tiny pictures under a microscope, by which means he can count the separate wing-feathers, and trace their overlapping distinctly. Figs. 4 and 5 are enlargements from a set of pictures representing the flight of a sea-gull. One of them is remarkable for showing the wings in the downward position. We may mention as a curious fact that European artists never represent this downward stroke of the wing, but that the Japanese frequently do.

But of all men who have turned the art of photography towards the study of animal mechanics, the palm must be awarded to Mr. Muybridge, of California, whose trotting-horse pictures have now become well known. Mr. Muybridge has recently read a descriptive paper on the subject before our Royal Society; and from this paper, and from other published accounts, we are able to learn the curious and ingenious method adopted to secure such marvellous results. In the first place, let us call attention to the remarkable atelier where these pictures are taken. All pre-conceived ideas gleaned from an ordinary photographic studio must be dismissed if we seek to understand Mr. Muybridge's arrangements. His operations are carried on in the open air, as shown in Fig. 6. On the right hand of the picture we see a long shed, under which may be discerned a row of twenty-four cameras. In front of this battery of lenses the ground serves as a diminutive race-course, along which the animal to be photographed can amble, trot, or gallop, according to pre-arrangement. The ground is covered with india-rubber, to prevent dusty clouds flying from the horse's hoofs. Each camera is fitted with an instantaneous shutter, controlled by electricity. From each shutter a thread stretches across the course, such threads being distant twelve inches from one another. The animal, in pursuing his way along the course, breaks these threads, putting each camera rapidly into action one after the other, and having his portrait taken in the particular position which he happens to be in when the thread is struck. Mr. Muybridge estimates each exposure to light to be $\frac{1}{5000}$th of a second.

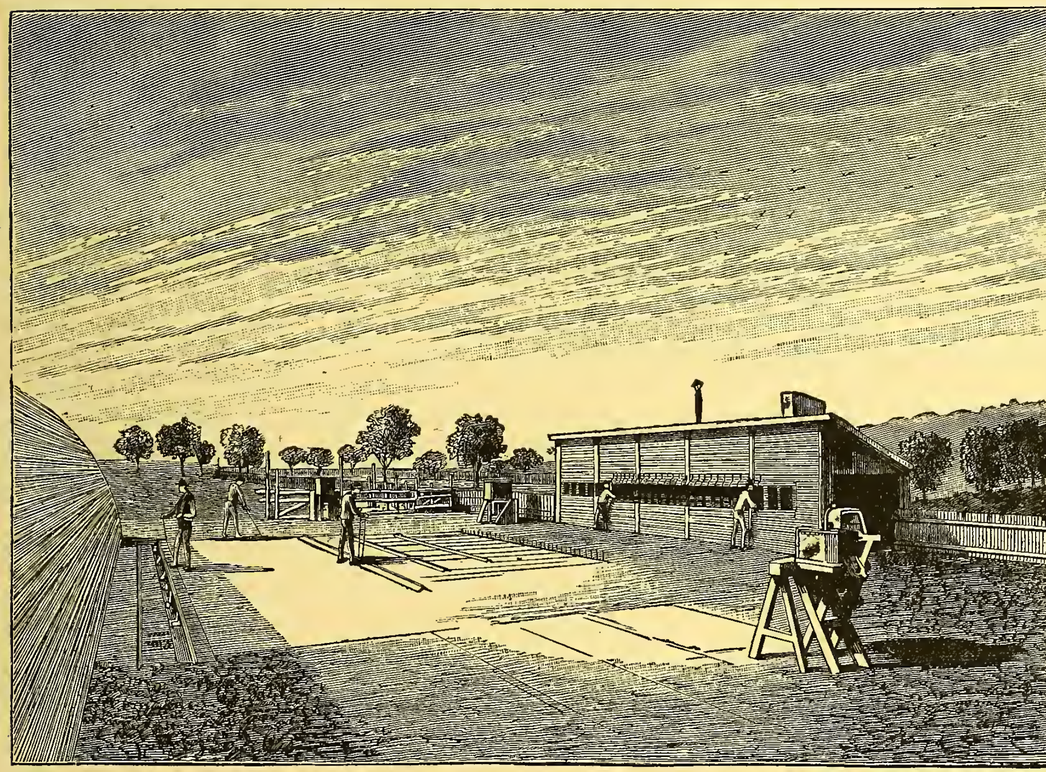


Fig. 6.—MR. MUYBRIDGE'S APPARATUS FOR PHOTOGRAPHING ANIMALS AT FULL SPEED.

These photographs of animals in motion have given rise to much controversy. The first thought on looking at some of the attitudes portrayed is, that they are unnatural and impossible. The next thought acknowledges that the camera cannot be guilty of misrepresentation, and that some other reason must be sought for these unfamiliar positions. The matter is explained when we remember that the eye, although the most perfect optical instrument to which we can point, has a certain peculiarity not shared by optical instruments made by the hand of man. The impression of everything that we look at remains upon the retina for about the one-eighth part of a second, although its existence, as in the case of a flash of lightning, covers really a far shorter period of time. This being the case, it is obvious that a movement occurring in less time than the period named cannot be appreciated by the eye. In looking at a galloping horse we observe the general effect of the movements, and involuntarily commute them into three or four positions. Such positions have been adopted by artists from time immemorial, and we have thus been taught to regard them as correct. Mr. Muybridge proves that even the best artists have in this way adopted attitudes which a horse in movement never assumes: therefore he argues that artists are wrong. We are inclined to think, in spite of these photographs, that they are right, for if they were to adopt Mr. Muybridge's new attitudes, it is certain that their pictures would represent positions that no human eye ever saw or will see in nature.

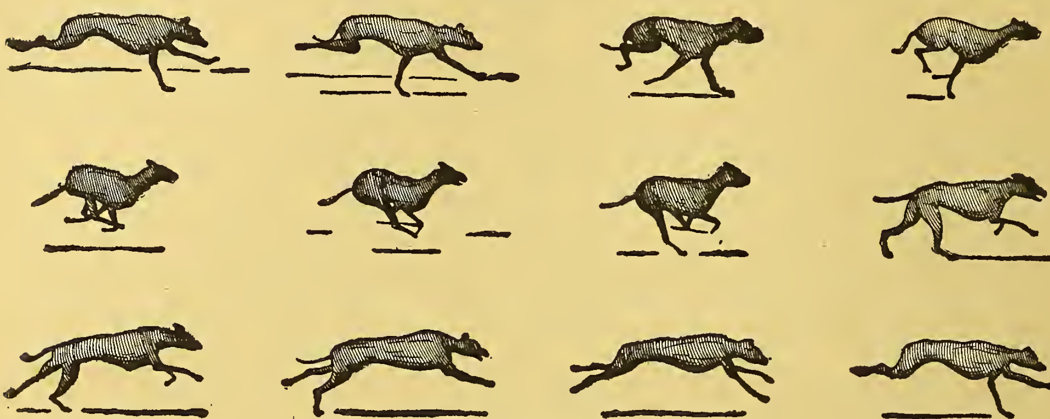


Fig. 7.—SUCCESSIVE ATTITUDES OF A GREYHOUND.

The trotting-horse photographs have been rendered so familiar by publication in various forms, that we abstain from reproducing them. But we give in Fig. 7 the presentment of a running dog, and the reader can follow the different attitudes as he follows the description of them given by Mr. Muybridge. He says: "The motion of the dog is very peculiar. Here (see the first attitude) he has alighted on one foot, changed it to the next forefoot, and then he leaves the ground with the forefeet. Then you find him entirely in the air, his feet all doubled up under him; he then comes down on his hind foot. Then he brings the next hind foot down, and leaves the ground again, so that he is in the air twice during a single stride —once with his body curled up, and the other when perfectly extended. I do not think that that fact has ever been commented on by a writer on natural history."

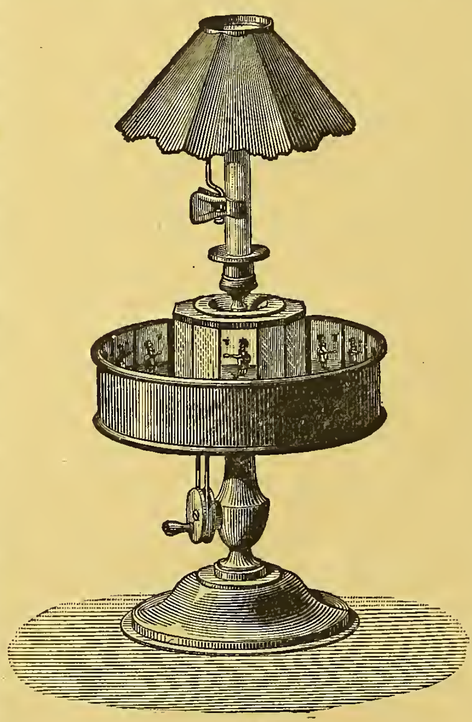


Fig. 8.—ZOETROPE.

It will thus be seen that it is possible to analyse a muscular movement, an operation which may be compared to that which a chemist does when he separates a compound body into its constituent elements. The reverse of this is when the chemist mixes elements together in certain proportions to produce a compound body, an operation called "synthesis." Strange to say, this can also be accomplished with Mr. Muybridge's photographs. Placed in an instrument called a zoopraxiscope, he was able before the Royal Society to cast the images of the different pictures so consecutively upon a screen, that they appeared to coalesce into actual movements. The possibility of doing this will be more fully understood by a reference to the zoetrope shown in Fig. 8, which has now, for a long time, been familiar in the shop windows. Two more pictures, copied from instantaneous photographs, Figs. 9 and 10, represent the human body in attitudes secured during two different forms of leaping. Human movements being less rapid than those of the lower animals, these photographs differ less than the foregoing from what might have been expected, but, like them, they show that there is really no limit to photographic possibilities.

Recent photographic exhibitions in London have taught us that English workers are by no means behind-hand in so-called instantaneous studies. Among these exhibits we may call to mind pictures of the Oxford and Cambridge boat-race, with the rival teams in full swing; a swallow flitting above a secluded pool; a dove pruning her wings, with a truant feather sailing away upon the wind; a bather suspended in mid-air as he dives into a stream; a boat in full sail with every rope reflected in the rippling waves, and many others too numerous to mention.

Fig. 9.—LEAP-FROG.

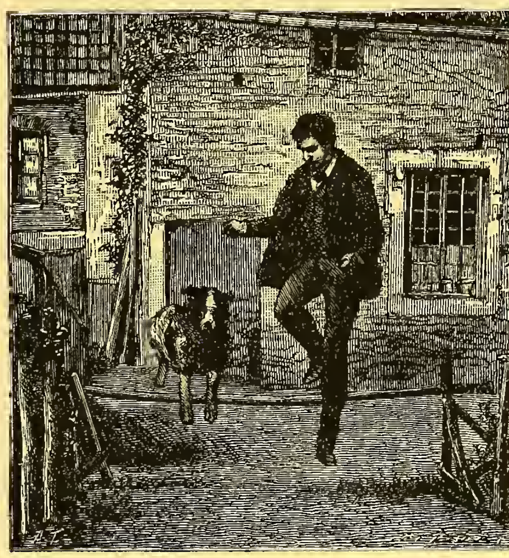


Fig. 10.—JUMPING.

In one of the fables of Fénélon, describing a voyage to an imaginary country, this passage occurs: "There was no painter in that country, but if anybody wished to have the portrait of a friend, of a picture, a beautiful landscape, or of any other object, water was placed in great basins of gold or silver, and then the object desired to be painted was placed in front of that water. After a while the water froze and became a glass mirror, on which an ineffaceable image remained." We may surely, in reading this passage, exclaim that the romance of the past cannot excel the reality of the present.

THE FEDAVEES.

DURING the twelfth century there roamed over the face of the civilised world the most odious class of beings—we cannot call them men—that had ever appeared in human form. These creatures, known by the name of Fedavees, were at once hated and feared in every country, as well by the sovereign on the throne as by the meanest peasant. From one end of the earth to the other, we read that Caliphs, Emperors, Sultans, Kings, Princes, Christians, Mahometans, and Jews, every nation and every people, dreaded the secret and unerring stroke of the Fedavee. Thus, Philip Augustus, King of France, receiving a mistaken warning that he had been marked a victim by this lawless horde, instantly surrounded himself with a body-guard of chosen men specially armed, and never appeared without a weapon in his own hands. Perhaps, however, nothing so strikingly exemplifies the terrible power of these murderers as the answer returned by their chief to a threatening letter from the Sultan. Bidding the Sultan's messenger follow him, he ascended a high tower, whence he commanded one of his subjects to fling himself to the ground. This order was at once obeyed without a murmur. He then bade another stab himself, and his submissive creature was a corpse next minute. "Go," said this autocrat, turning to the messenger, "tell your master that I have 70,000 men ready to do as much."

The head-quarters of this Ishmaelite brood was amongst the mountains to the south of the Caspian Sea. The whole community was divided into seven orders, or grades, all subject to the control of a grand master, known throughout Europe as "The Old Man of the Mountains." The first Old Man of the Mountains was Hassan ben Sabah, who organised the society in the year 1090 A.D. into the form in which it became known to Europeans. The members of the sixth and seventh grades were strictly brought up to regard the teachings of the Koran as their rule in life. The other five grades, which comprised the initiated, interpreted the Koran to suit their own inclinations, and looked upon human actions as in themselves neither good nor bad. An action was good if it were in accordance with the wishes or the commands of their leader; the same action became bad when it was in opposition to these wishes or commands. Men with such a creed could be nothing else than the merest instruments of their chief.

The Fedavees were the members of the fifth grade, and it was their business to carry out what may be called the foreign policy of the Old Man of the Mountains. This scourge to society derived his revenue mainly from the secret pensions that he received from even kings and other potentates, who thus bought, by paying blackmail, safety to their persons. Let one of these kings cease to advance his tax, and a Fedavee was forthwith despatched to take his life. Besides sovereigns, others occupying a less elevated position were also tempted by their fears to contribute to the coffers of the Old Man. It is easy to see that a revenue derived in this way would very soon cease unless an example were made of all that sought to evade such payments—to furnish such examples was the duty of the Fedavee.

These misguided creatures, often stolen or purchased when young, were early trained in the belief that their master was omnipotent, and that even to attempt to disobey his most repulsive commands was a crime. At home they wore a white uniform with red bonnets, and carried sharp daggers in their girdles. When sent on a mission, however, they assumed whatever disguises might seem best adapted to elude suspicion. They would insinuate themselves into courts in the guise of minstrels, and beguile the laden hours with wild and weird melody; or perhaps as stranger-pilgrims they would accept the hospitality which the weary step and travel-stained garb prompted the generous to proffer. Then in the dead of night, clutching the dagger that had been so carefully concealed, the Fedavee, remembering nothing but the mandate of his master, would stealthily seek his victim, plunge the steel into his heart, and disappear. It mattered not how long the Fedavee had to wait for his opportunity; his patience and his resolution never gave way. He knew that if he failed to fulfil his mission his own life would soon be taken.

Another powerful stimulus urging the Fedavee at all hazards to complete his murderous enterprise was the strange and repulsive process whereby he was fortified before setting out on a mission. He chewed the hashish (hemp-plant), from which he was sometimes named Hashishim—a word that became in Europe *assassin.* This plant threw him into a stupor, and while he was in this state of unconsciousness he was borne to the Garden of Alamoot, where, on awakening, according to Marco Polo, everything that could cause him pleasure and everything that he could desire were administered to him. These pleasures, he was further taught to believe, were only a foretaste of the future bliss designed to the faithful. This future bliss would be his if he fell in seeking to obey his master, while he would lose it if he sought to shrink from yielding a submissive obedience. Relying upon such a faith, he set forth, cared not what difficulties he might have to confront, and firmly resolved "to do or die." When we remember this, we cease to wonder at the list of illustrious victims that fell by the lawless hands of the Fedavee. Mostarsched, the Caliph of Bagdad in its palmiest days, the son of the powerful Caliph Mostali, and a distinguished Turkish vizier, Nizam ul Mulk, are mentioned amongst the great men who thus died. These rulers possessed more power than the sovereigns of Europe in those days: we are therefore not surprised that the life of one of the Edwards of England was attempted. The attempt was, most likely, not a very serious one, as it is otherwise difficult to understand how he managed to escape.

The power of this awful society, Gibbon tells us, was broken by the Mogul conqueror, Holagou Khan, in the year 1258; "and not a vestige is left of the enemies of mankind except the word *assassin*, which, in the most odious sense, has been adopted in the languages of Europe." Fit termination to such a fiendish band.

FLYING ANIMALS.

THE term "flight," as applied to animals, and to special groups of the animal world, is a very varied appellation, and one to which various meanings may be attached. In its most common acceptation we use the word "flight" to indicate that perfect freedom of movement in the air which is possessed by the bird or by the insect. Amongst quadrupeds, or "mammals," the bats, as is well known, possess flying powers almost co-extensive with those of birds. Most bats possess a very powerful flight, and sweep through the air with rapidity and force. Those extinct reptiles, the *Pterodactyls* (or "winged-fingers), whose fossil remains are found in the "Middle-period," or Secondary rocks, must likewise have possessed powers of flight allied to those of the bats. Their flying apparatus was of similar description to that seen in bats, and consisted of a fold of skin, which stretched between the greatly elongated finger, along the sides of the body and fore limbs, to the hind limbs and tail. In bats, as most readers are aware, four of the fingers are greatly developed, and support the wing-membrane, which has a disposition along the body well-nigh similar to that seen in the extinct reptiles.

No living reptile "flies," using that term in the sense in which we apply it to bats, birds, and insects. The nearest approach to flight we see in living reptiles is found in the lizards known as "flying dragons." These inhabit the East Indies, and are able to take flying leaps from tree to tree. In these aerial jumps they are supported as by a kind of parachute, by the fold of skin which is borne by six of the front ribs, specially modified. We can clearly see, however, that this membrane is not a "wing." It is not moved as a wing is

TAGUAN (*Pteromys petaurista*).

moved, and it cannot support its possessor in the air. Of certain quadrupeds the same remark holds good. All the "wing" can do is to prevent the animal from sinking to the ground for a good while, so as to enable it to take a good long "flight" before any single leap is exhausted. It is a sailing or floating along rather than flight.

Thus there are some members of our own class, ranked among the "marsupials," or kangaroo order, which possess folds of skin stretching along the sides of the body between the fore and hind legs, and which are enabled, like the flying lizards, to take leaps from tree to tree. The flying lemurs (*Galeopitheci*) possess a well-nigh similar adaptation, these latter forms being allied to the insectivorous animals, such as the moles, shrews, hedgehogs, and others.

But perhaps the best known of the "flying animals" belong to the race of "flying squirrels," so-called. The best known species of these animals is figured in our illustration. This is the Taguan (*Pteromys petaurista*). It is depicted in two of its familiar attitudes, firstly as reposing on the branch of a tree, and secondly running on the ground. Here the term "flying" is manifestly misapplied. The Taguan has no power of flight. It merely leaps from branch to branch, and the membrane fringing its body, and which gives to its body a great apparent breadth, assists it in its arboreal leaps.

The Taguan itself is one of the larger forms included under the name of "flying squirrel." The tail inclines towards a bushy structure; and exclusive of the tail the animal's length is about two feet. The colour above is a greyish-black hue, whilst a lighter tint prevails beneath. The ears are pointed, and as is common with most nocturnal or night-hunting animals, the eyes are large and prominent. The native lands of the Taguan are India, Ceylon, Siam, and Malacca. The nest is made in the holes of trees, and at night it emerges forth on its foraging expeditions. The food appears to consist chiefly of fruits and seeds. The tail has been credited with acting as a rudder in its aerial flights.

It is interesting to note that "flying squirrels" with rounded tails occur in India, and also in China and Japan; and we also know of another group in which the hairs of the tail are arranged in a double row, the tail itself being flat. But all of these forms, however distinct they may be as species, in the eyes of naturalists conform to the general type we have seen represented in the Taguan itself. Just as the whale or seal is a quadruped modified for a sea-life, or as the bat is modified for perfect flight, so it seems the Taguan and its neighbours represent a peculiar development of movement adapted to assist tree-living habits, rather than to mimic true flying powers.

THE GREAT WALL OF CHINA.

NEXT to the huge pyramids of Egypt, amongst the wonders of the world ranks the Great Wall of China. Father Gerbillon, who had the opportunity of inspecting it, describes it as one of the most astonishing of man's works, and states that from the Eastern Ocean to the frontiers of the province of Chan-si, or for the distance of two hundred leagues, it is chiefly of stone and brick, with towers sufficiently near each other to be mutually defensive. At every important pass it has a strongly-built, ably-designed fortress. In many places the wall is double, and in some triple, but towards the western extremity it is merely a terrace of earth. In parts it travels up and down, traversing the steepest and highest rocks; and Father Gerbillon confessed that he was utterly unable to conceive how the materials were conveyed to these wild, rugged spots, where, he adds, the boldest of our European builders would not attempt to raise even the smallest building. It consists of an inner and an outer wall, each constructed of brick and stone, many feet apart, and not more than a foot and a half in thickness, the space between being so filled in with earth that the whole appears one huge solid mass of masonry. For six or seven feet upwards the foundations are formed with great square stones, the rest being of brick. The top is paved with flag-stones. The towers are each about forty feet high, and the height of the wall averages about twenty feet. Both towers and walls are embattled, and the former are at the base about fifteen feet square. They diminish as they ascend. Nearly all the gates open into towns or villages.

Mr. Barrow, writing of this wall more than half a century ago, calculated that the materials of all the dwelling-houses then in England and Scotland (1,800,000), averaging 2,000 cubic feet of material, stone or brick, would be barely equivalent in bulk to the material used in constructing this great wall! He did not include in his curious calculation the stone and brick used for the towers and fortresses, which alone, he added, would represent as much material as would build another London! A calculation which included the mass filling in the space between the walls, as well as the walls themselves, showed more than sufficient material to surround the globe, on two of its large circles, with two walls of two feet thickness, six feet high!

The Great Wall has but two gaps, these being in places rendered inaccessible by nature. It has numerous sally-ports, and each tower was used for a beacon-fire, to spread an alarm rapidly along its entire length.

In the vicinity of towns the top of the wall, which is reached at intervals by stone flights of broad steps, is used as a pleasant and healthy promenade. From the gate of Sining-fu to the city of Lucien, before the desert, is a journey of eighteen days. The contrast between the cultivated country within and the wilds beyond the wall is sometimes singularly striking : on one side habitations with fields and gardens, on the other a desert untrodden by man, and given up entirely to savage beasts. The immense antiquity of this mighty wall, striding over plains and mountains, stretching over rocks and hills, sweeping down into deep valleys, and travelling up the sides of almost perpendicular precipices, is overpoweringly impressive. Kircher, the missionary, wrote of it :—

"The work is so wondrous strong that it commands the world's admiration to this day ; for through the many vicissitudes of the Empire, changes of dynasties, batteries and assaults, not only of enemies, but of violent tempests, deluges of rain, fierce winds, and severe weather, it displays no signs of demolishment, and is neither cracked nor weakened by age, but appears almost in its first strength, greatness, and beauty. And well it may be so : for its solidity whole mountains, by ripping up their rocky bowels for stones, were levelled, and vast deserts, covered with deep enswallowing sand, were swept clean down to the firm ground beneath."

The wall was erected, say the Chinese, two centuries and a half before the Christian era commenced, and occupied but five years of labour, every third man in the Empire capable of work having been engaged upon it, the greater number of whom, says tradition, sacrificed their lives in executing the work, so arduous and fatiguing was it. It is difficult to credit this tradition.

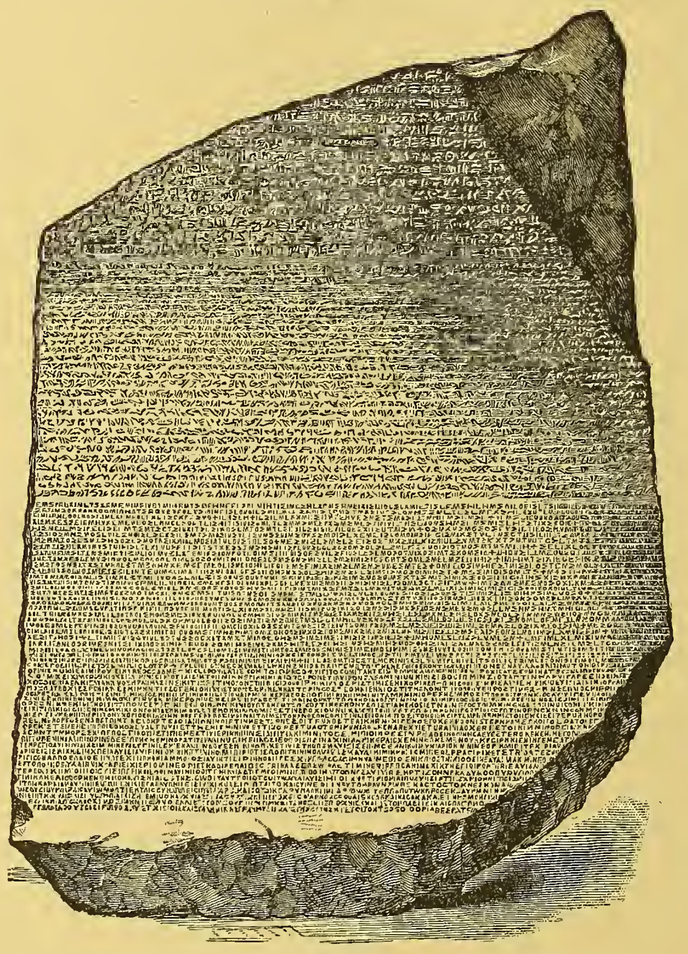
EGYPTIAN HIEROGLYPHICS.

EGYPT is a land of mystery to most of us, and its history is so ancient, and apparently so utterly unconnected with that of any other country, that it seems to be a world apart from the rest of humanity, and to possess at best an interest only for itself. Of the pyramids, the sphinx, and of the mummies every one had of course heard, but they excited only the curiosity of a few, and no one could explain the reason of their existence. Though some accounts of the habits of the Egyptians were to be found in the classic authors of Greece and of Rome, these represented a state of affairs so strange and incomprehensible that little value was attached to them, and they were in fact almost, if not entirely, discredited.

Yet the archæologist and historian, beholding the stupendous monuments of this mysterious race, and noticing upon many of them innumerable drawings apparently arranged upon a definite plan, felt that, could they but succeed in discovering a means of interpreting these symbols, much, if not all, the information they sought would be at their command. It was supposed by the ancients that the knowledge of these symbolical writings was confined exclusively to the priests of the Egyptians, and that with them that knowledge expired, never again to be recovered. And so for some sixteen hundred years the innumerable sculptured monuments, the carefully-drawn papyri, and the equally delicate devices upon many of the cerements of the dead, remained, as it were, a sealed book to the historians of more modern times. With innumerable records of a forgotten history before them, in the form of inscriptions in what are termed hieroglyphic characters, the learned of all countries were compelled to confess themselves unable to solve the problem thus presented ; and it appeared probable that the ancient monuments would for ever remain a marvel and a mystery to the world.

It must not be supposed that no attempts were ever made to arrive at a correct perception of the meaning of these writings. Many great linguists had puzzled their brains to discover the hidden value of the strange symbols before them ; but it was probably an impossible task, or at least it proved so, until unexpected help came to hand to aid in the labour of interpretation. Guesses had indeed been made, with more or less success, as to the meaning of certain constantly-recurring signs, and amongst others the names of Ptolemy and of Alexander were identified after some strange mode. The names having been arrived at, M. Silvestre de Sacy was the first to conclude that the groups of signs representing these names were letters, while Mr. Akerblad, a Dane, endeavoured, to some extent successfully, to recognise and separate most of these alphabetical elements from the proper names. Mr. Akerblad, however, seems to have arrived at his conclusions from the preamble alone of the decree he was studying, and this being composed almost entirely of foreign proper names, he failed to discover a most important fact—namely, that in common with most Orientals, and even the Hebrews, the Egyptians were in the habit of suppressing all, or nearly all, the intermediate vowels in their writing. Hence, though he had succeeded in evolving an alphabet, which, as far as it went, was tolerably correct, yet when he endeavoured to interpret other inscriptions he found himself entirely at a loss, and his troubles were not a little added to by the fact that no spaoe was left to separate one word from another, but that the signs followed each other in endless succession, without break or pause. One great result he had, however, reached : he had proved that sometimes, if not always, the Egyptians employed hieroglyphics as letters, and that these letters bore no little resemblance to those of the Hebrews. And here, perhaps, the discoveries would have stopped, but for a most fortunate and unexpected aid—the finding of the now famous Rosetta Stone.

This stone, which is now safely deposited in the British Museum, is a block or pillar of black basalt, which many years before had been discovered by the French while disturbing some ground at Rosetta. On it are three inscriptions, one of which, in the Greek language and character, was comparatively easily deciphered, and at its conclusion conveyed the information that the decree which it set forth had been ordered to be engraved not only in Greek, but in the sacred and in the popular letters of ancient Egypt. It unfortunately happened that not one of the three inscriptions was perfect, so that it was difficult to correlate any particular portion of one inscription with any particular portion of the remaining two. The "demotic," or popular inscription, was, however, sufficiently perfect to at length enable some comparison to be made, and it was found that where in the Greek inscription the names of *Alexandria* and of *Alexander* occurred, in the demotic inscription certain groups of symbols could be recognised which unquestionably represented these names. By another method it was found that a certain group of characters occurred in the demotic inscription some twenty-nine or thirty times, and that in the Greek no word was so often repeated, except that of *King*, which was met with, either separately or with its compounds, about thirty-seven times. In like manner the names of Ptolemy, Berenice, and Egypt were identified by their position or by the number of times which they occurred, while a small group of characters, which occurred very frequently in almost every line, was eventually shown to mean *and*. By such means as these sufficient points of departure were at length obtained to enable the indefatigable investigator to write the Greek over the demotic or enchorial inscription with a tolerable certainty of their general coincidence, and thus it was clear that the intermediate parts of each inscription must also approximately correspond the one to the other. By this laborious process the meaning of most of the demotic characters was made out, and its correctness established by tolerably conclusive evidence.



THE ROSETTA STONE

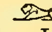
Then came the equally difficult task of identifying the sacred, or, as they are sometimes called, "hieratic" characters—these being in fact the true symbols to which the name of "hieroglyphics" should strictly apply. A discrepancy had been observed between the Greek and the demotic inscriptions which occasioned their interpreters some little trouble. This consisted in the fact that while in a certain passage of the Greek inscription the name of Ptolemy occurred but twice, in the corresponding demotic passage it occurred three times. The difficulty was, however, accounted for by supposing that while in the one case the king was referred to by name, in the other his titles only were given. With this knowledge it was easy to select in the sacred inscription three groups of symbols, which, by their position and conspicuousness, would sooner have been identified with the name of Ptolemy but for this disagreement with the accurately deciphered Greek passage. Some further difficulty was found as to the direction in which the hieroglyphics were to be read. In Greek and Latin the letters read from left to right; in Hebrew from right to left; in Chinese from top to bottom. It was only gradually discovered that Egyptian hieroglyphics read all sorts of ways, and that the only general key to this was to read from the direction in which the animated objects were looking. It was also found that the names of sovereigns were distinguished by being enclosed in a border or *cartouche.* These elementary discoveries formed the foundations upon which all else had to be constructed, and it is very interesting to trace the general method by which Champollion in France, and our own Dr. Thomas Young, equally celebrated for his discoveries about the true nature of light, by degrees got at the heart of the great mystery.

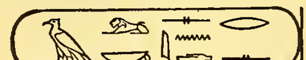
FRANÇOIS CHAMPOLLION.

Condensing the account given by Dr. Birch of this interesting discovery, it was found that in the Rosetta Stone the cartouche most often occurring in the hieroglyphics, and which it was almost certain represented the Greek Ptolemaois, was that here represented :—

Now it happened that not long after another inscription in two languages was discovered on the plinth of an obelisk found in the island of Philæ. Here the Greek name was Cleopatra, and the only cartouche which could correspond to it in the hieroglyphics was the following :—

Here were two names to work on; and this was the method. Both names contained several similar sounds, and in Ptolemaios, if □ were the first, that sign must represent P. It was found, as can be seen at a glance, that this same sign □ did occur fifth (CLEOPATRA) in the other cartouche. So far good. The third sign in Ptolemaios,

was probably O, and the next one to that, , probably L, most likely from the initial of the word which, as *leo* or *lion*, occurs in so many languages. These two did come second and fourth in CLEOPATRA—good again. After a while another name, Alexander, was identified in the following cartouche :—



and from the first sign in this, the A already identified in CLEOPATRA was confirmed, as also the L. This is quite sufficient to indicate how by degrees the signs were tracked down; and when, years afterwards, another stone was found, known as the "Decree of Canopus," which contained a royal document in hieroglyphic characters and demotic writing, also with a translation in Greek (this inscription, unlike the Rosetta stone, is unmutilated) it was found that a translation made independently by Egyptologists, who had not seen the Greek version, agreed almost exactly with the latter.

Let us now glance at a few of the characters contained in Dr. Young's vocabulary. The Egyptians, whose gods seem to have been almost as numerous as the population, employed two signs to represent *God*—one, resembling a peculiar form of hatchet, indicated the god of power; while the other, a figure either seated or standing, without distinct arms or feet, and with the head either of a man or a hawk, represented the god of judgment, and was sometimes, therefore, employed to signify *lawful*. In the former case the plural was formed by increasing the number of hatchets to three, while in the latter the figure was followed by three small squares, one above another—the usual method of representing plurality. For goddess the same characters were employed, followed by the symbols always used to denote the feminine gender—namely, a semicircle surmounting an obliquely placed oval.

Amongst the gods we find Phthar, the Egyptian Vulcan, represented by a curious character, which would seem to have been intended for a plough, and to allude to the Egyptian belief that Phthar was the inventor of implements of war and of husbandry. Osiris, the principal deity of the Egyptians, is represented by a human eye surmounting the rude figure of a throne, while his sister and wife, Isis, is depicted by the throne alone, followed by the feminine symbols already described. Joh, the moon, is denoted by an upright crescent containing a small semicircle, while Phre is represented by a circle with a point in the centre—a sign which also denoted the sun, and which, passing from the Egyptians to the Latins, is even now, after the lapse of innumerable centuries, employed by our own astronomers with the same signification. From the names of sovereigns enclosed in cartouches, and a few other proper names, it is possible to trace the steps by which alphabetical writing has arisen out of hieroglyphics. The demotic or enchorial name of Ptolemy appears to differ greatly from the hieroglyphic. Yet by the help of innumerable "epistolographic" manuscripts, a real resemblance and clear derivation can be made out.

Thus it will be seen that there are several forms of hieroglyphics, the characters of which vary considerably. In the sacred writing the symbols are sometimes phonetic, as when a feather stands for A or E; sometimes they are symbolic or emblematic, as, for instance, the hawk's head, surmounted by a disc, standing for the sun; and sometimes they are figurative or pictorial, as when the image of a man is employed to indicate *man*. There is another class of hieroglyphics, sometimes termed the sacerdotal, in which the signs are so abbreviated as to render them difficult of identification, but which are nevertheless both figurative, emblematic, and phonetic in their values, and are clearly traceable to the sacred characters. And lastly, there are the demotic characters, which have been immediately derived from the sacerdotal, but in this nearly all figurative characters are excluded, and a rude and unwieldy running hand is at length arrived at, for the decipherment of which we are indebted to the collective researches of a large number of men. At last we are able to claim what at one time was wholly despaired of—the ability to interpret with tolerable, if not with complete accuracy, any of the innumerable Egyptian inscriptions which may come into our hands.

THE ICE PALACE OF MOSCOW.

"Silently as a dream the fabric rose;
No sound of hammer or of saw was there:
Ice upon ice, the well-adjusted parts
Were soon conjoined, nor other cement asked
Than water interfused to make them one."

THESE lines, taken from Cowper's "Task," refer to the wonderful freak indulged in by the Russian Court during the reign of the Empress Anne. In the year 1732 a grand review was held upon the frozen Neva, in which many thousands of Russian troops took part. An ice castle was reared and manned by soldiers; artillery manœuvred, and, indeed, all the military tactics of those times were gone through with as much freedom as our soldiers experience in careering over the solid ground of Woolwich Common. The Neva, however (no doubt, at the suggestion of this review), was destined soon to be the scene of a still greater marvel, for seven years afterwards there arose upon its banks what may appropriately enough be called the biggest plaything hitherto seen—the ephemeral Ice Palace of Moscow.

The winter of 1739 was remarkable all over Europe for its severity; in fact, our own Father Thames succumbed to the fierce grip of Jack Frost, and it has already been told how a fair was held upon his ice-bound bosom (see p. 35).

Into the mind of an idle Russian courtier there entered a scheme which rivals the most fantastical day-dream that ever beguiled the simplest child. To this scheme the consent of the sovereign was granted; and as a sort of pretext for rearing so elaborate a structure as an ice palace, it was resolved to make it the means of commemorating the marriage of Prince Galitzin with a peasant girl, the newly-wedded pair being, by way of frolic, expected to pass the night in one of the rooms. Workmen were speedily despatched to the Neva, from which they extracted blocks of ice three feet thick, and conveyed them to the selected site, where they were placed one upon another, the only cement being water, which froze the blocks together. Thus arose the fairy fabric, under the personal superintendence of its original deviser, Alexis Danielowitch Zatischchew.

According to the most authentic accounts, the length of the palace was fifty feet, its breadth eighteen feet, and its height twenty-one feet. It consisted of only one storey, and had no ceiling. Its sloping roof—all ice—was ridged in imitation of tiles, and mounted by chimneys. An ice balustrade, elaborately wrought and adorned in every way that artistic taste could suggest, surrounded the palace, enclosing also a garden, or court-yard, which was entered by means of two gateways in the rear. This garden was embellished by a profusion of tropical plants. Orange-trees, nearly as high as the mansion itself, bearing fruit and flowers, with richly-plumaged birds on the branches, lured the fur-clad visitor as he approached into the momentary belief that he had suddenly come upon some enchanted castle smiled upon by the genial sun of summer. A nearer scrutiny, however, dispelled the delusion, and the disappointed stranger found that the gay colours and brilliant verdure of this Oriental-like scene were the result of the prosaic labours of the painter and the delicate handiwork of the artificer—the trees, the flowers, the fruit, and the birds were all chiselled out of the same cold pellucid marble of "the glassy wave!"

The front of the evanescent palace itself, which glistened in the sun like a massive diamond, invited entrance by a few steps leading up to an apparent door, surmounted by a Roman arch. On each side of the doorway, with its column-supported portico, were three large windows, their framework of ice painted to appear like marble, and their icy panes as lustrous as the finest plate-glass. In front of each window stood a cannon regularly turned and bored, and mounted on carriages with wheels—all of ice. On the immediate right and left of the doorway were two large mortars for shells of 80 lb. Beside each of the mortars was stationed upon a pedestal of ice an icy dolphin. Standing out a little into the garden, two colossal pyramids as high as the chimneys contributed towards the imposing aspect presented by a front view. On the left side of the palace was a life-sized elephant, with a man dressed in the garb of a Persian on its back; two similar figures, one armed with a lance, stood near. Such was the external appearance of the ice palace. Everything was ice except the paint. Let us now enter the strange structure.

Admission was effected at the back, the front door, already noticed, being only an imitation. A lobby ranging from back to front, and finished with every appliance and ornament usually found in the royal mansions of those days, separated the two large apartments of which the palace consisted. These apartments, sumptuously furnished and elegantly painted, contained nothing but ice.

> "Convivial table and commodious seat
> (What *seemed* at least commodious seat) were there;
> Sofa and couch, and high-built throne august.
> The same lubricity was found in all,
> And all was moist to the warm touch; a scene
> Of evanescent glory, once a stream,
> And soon to slide into a stream again."

Yes: tables, chairs, statues, looking-glasses, candles and candlesticks, fireplaces filled with logs of painted ice, mantelpieces made to resemble the glossiest marble, tea-dishes, tumblers, wine-glasses, a state bedstead, with wavy-*looking* curtains, bed, pillows, and snow-white quilt, two pairs of icy slippers, and two icy night-caps: all smiled, and all were cold. Fine place this for Prince Galitzin and his peasant bride to spend their honeymoon in! We are not told that the prince availed himself of these vitreous apartments.

Soon after it was all completed, the Empress and the whole Russian Court came in state to admire the wonderful work of art. We read that as the cortege approached a salute was fired from the icy cannons—the balls being compressed tow—the mortars threw shells high into the air, and the elephant discharged from his trunk a watery spray. The gay hues of the Court dresses sparkled and glittered on every hand; in fact, the brilliancy of the diamond was outshone. Experiments were made with the cannons, and a real bullet was driven through a two-inch board at a distance of sixty paces, a quarter lb. charge of gunpowder being used. The next visit of the Court was made by night, when the palace was illuminated. For this purpose naphtha was used; and flaming streams issuing from the mouths of the dolphins and the elephant flashed upon the crystalline mass, and lit up the building with surpassing radiancy. It was like a sun. Inside the candles were smeared with naphtha, as were also the imitation logs; these were lit, and helped to complete the deception. All this resplendent magnificence, however, was short-lived; and, although no labour had been spared, yet before the end of March not one vestige of all that toil remained.

Since the days of this ice palace, structures of the same unstable material have now and then been raised. None of them, however, have exhibited any feature worthy of special note. It is a common enough thing in countries—such as Canada—where snow is abundant, and plenty of skating is to be had, to cut out labyrinthine aisles and snug grottoes to give variety to the skater's course. This, however, is not indulged in to any greater extent than is compatible with the prevailing ideas of economy in these days of ours. It is, therefore, extremely unlikely that the world will ever see a rival to the Ice Palace of Moscow. As man progresses he directs his labours less and less upon mere aimless magnificence, and more and more upon the substantial and the useful. Hence it happens that there are in modern civilisation no pyramids, no grotesque ice palaces, and none of that barbaric splendour which we find associated with the courts of dusky princes and great Mogul Emperors. At the time of the Ice Palace at Moscow, Russia was just emerging into a European Power, and, like the rest of these Powers, she soon found more practical and more profitable channels into which to turn her efforts.

LIVING FISH ILLUMINATED BY ELECTRICITY.

THE ELECTRIC LIGHT IN SURGERY.

ALTHOUGH natural doubts exist as to whether the electric light, in its present forms, will soon displace gas to any serious extent as an illuminant, there are various special uses to which it can be even now applied with great advantage. Our present purpose is not to enumerate these, but to point out how, in the surgeon's hands, it can be made to render a service which no other form of light can render so well. In many surgical operations it becomes necessary to deal with open wounds, and natural cavities in the body where no, or little, light can be made to penetrate. In most of our hospitals, for this class of operations, the condensed beam from a limelight is employed; but it is obvious that this source of illumination can only be limited in its applications. A limelight is, at the best, a cumbrous affair, and must, on account of its heat and necessary adjuncts, be kept at a respectful distance from the object illuminated. Of what service, for instance, would the limelight be to the dentist, if he wish to examine the general aspect of the interior of the mouth? In asking this question we quite put aside the necessity for two gases under pressure, or one at least, without which that form of illumination is impossible. To meet this want, M. Trouvé has designed a form of electric lamp, which, under the name of the electrical polyscope, can be placed inside the mouth, and which will shed a light so brilliant that every detail is visible, and the teeth themselves are rendered quite translucent.

We are apt to identify the electric light with dynamo machines and steam-engines, which would be quite out of harmony with the delicate manipulation represented by a dentist's or surgeon's work, but, in the present case, no such tremendous aid is necessary. A battery of simple and portable form will render luminous a coil of thin platinum wire, and to such a mode of illumination the polyscope owes its efficiency. The light given, feeble in itself, is quite sufficient to illuminate brightly any cavity in which it is placed, although it would be quite insufficient to serve the same purpose for the smallest room. It may be described as a coil of platinum wire fixed at the end of a convenient handle, and furnished with reflectors of a parabolic form, whose shape is altered for different purposes. Sometimes, when the actual cautery has to be applied, the platinum wire gives place to points or wires of other form, which become white hot when the current is established. The wire may also be enclosed in an exhausted glass bulb like those of the well-known incandescent lamps, though, of course, considerably smaller. But, for general purposes, the instrument takes the form of a dome-shaped reflector of bright metal, in the focus of which the little coil gives out its light like a brilliant glow-worm.

In addition to the instrument itself, and its attached battery, a resistance-coil, or regulator, is placed in the circuit, whose duty it is so to control the current, that while the platinum coil is kept at white heat, and near its melting-point, actual fusion is rendered impossible. It should be here mentioned that, although the melting-point of platinum undoubtedly represents an extreme temperature, the heat radiated from the little coil is so small that no inconvenience is felt from its presence close to, and almost touching, the seat of operation. It can, in fact, be introduced into the œsophagus, and in this situation will light up the cavity of the stomach.

At a recent *soirée* in Paris, the inventor successfully demonstrated, in a popular and inoffensive manner, the efficiency of this clever piece of apparatus. Our illustration will show the manner in which this was accomplished. A living fish, swimming in a tank of water, had placed within it a closed transparent envelope containing the platinum coil. The operator's hand grasping the holder, and making contact with his thumb, is shown on the right-hand side of the drawing. When the room was darkened, those present could see every detail of the fish's organism, and could count the divisions (vertebræ) in its back-bone. The experiment was not only successful, but was, in its way, unique. It showed that observation might be obtained by the polyscope of interior conditions which no other instrument can afford. Any one having only slight surgical knowledge will at once see of what great use such a contrivance must be in special cases.

M. Trouvé considers that his invention may be applied to mines, powder magazines, and diving operations, including the coral and oyster industries. Of these applications we have some doubt. Probably these operations need something giving more light than the polyscope. But, as we have already indicated, that amount of light is puite enough for surgical purposes.

MATTER AND ITS PARTICLES.

To the careless observer who takes into his hand a piece of anything—let us say a lump of sugar—it appears so simple and tangible that it never probably occurs to him to think what it really *is*. If he thinks at all about it, he probably only thinks that it is a "material substance;" but if he reflects further what he *means* by material substance, he will soon cease to wonder that the true nature of Matter—the true essence of that Reality which lies behind the universe in which he dwells—has exercised the most profound thought of every age, and that no certain statement can be made about the problem even yet. Nevertheless, much in detail has been ascertained which it is of great interest to know.

We go back to our lump of sugar, and easily crush it into little lumps. With a pestle we grind it up into fine powder, so fine that no particle can be distinguished by the eye; but we perceive that each tiny bit is still sugar, and the powder tastes the same as the lump did, and behaves exactly the same in other ways. We throw it into water, and thus we divide it into smaller particles still—so small now that they become quite invisible; but still the sugar tastes sweet, and behaves chemically as sugar in every way. We thus recognise that whatever matter is, its properties reside in almost inconceivably small particles, and not in the great mass, as a mass. We might suppose—and it was once supposed—that there is no limit to this smallness of the particles; but there we come face to face with another class of facts. The smallest bit of sugar we could get by crushing or pounding, or even by dissolving, was sugar unmistakably. But let us carefully weigh a certain quantity of sugar, and add to it in a saucer a small weighed quantity of water, then finally a weighed quantity of pure sulphuric acid. Masses of a porous black substance begin to heave and swell out of the saucer, of much greater bulk than the sugar itself. When all is quiet and has cooled, we find that this black substance is neither more nor less than *charcoal;* but though so bulky, it weighs much less than the sugar did. We weigh the rest of the products, and we find the sulphuric acid is still there, and that the weight of the small quantity of water is increased by exactly the amount that the charcoal weighs "short." Now, we know that sulphuric acid has an intense affinity for water, so intense that an egg can be cooked in the heat produced by a sudden mixture; and we are obliged to conclude that the acid has seized upon this water when locked up in the sugar, and that we have, in fact, simply divided the sugar into two sorts of still smaller particles, which, when separated from one another, and combined by themselves into mass, come out as charcoal and water. We may go further, and subject the charcoal and the water to all sorts of processes; but there we find a difference. The charcoal, or carbon, we can divide no further. We can combine it with other things, and thus obtain quite different-looking substances, which weigh *more;* but we cannot get out of it anything which weighs *less.* The water, on the contrary, we can easily divide by a galvanic current into two gases, called oxygen and hydrogen, which, when mixed together as gases, and exploded by the electric spark, will, on the other hand, *make* water. Neither of these gases can be split up any further.

Such things as the oxygen and hydrogen and carbon are therefore called simple "elements" by chemists, whereas bodies which can be divided into elements are obviously compounds. Of the simple elements about sixty-six are known, but many of them are only found by difficult processes and in extremely small quantity. The curious thing is, however, that there is nothing in the colour or taste or weight, or any other tangible property, to tell us whether any substance is an "element" or not. Many elements, such as metals, are not only much alike outwardly, but strangely alike in their chemical behaviour; while taking, on the other hand, a piece of pitch and a piece of sulphur, there is nothing but the result of our chemical processes to tell us that the pitch is a compound, and the sulphur, so far as we know, is not. It is not to be wondered at if the old alchemists supposed that since they could so change the form of many substances they could change all, and transmute the baser metals into gold. The strangest thing, perhaps, is that many modern chemists believe even the elements are different forms of some one primordial matter, although they differ from the alchemists in not believing man is ever likely to be able to transmute one form into another.

But these facts led to the knowledge of another concerning combinations of the elements. By precipitating it in a peculiar way with the help of hydrogen, we can procure iron in powder so fine that ere long it takes fire from exposure to the air; and we can also reduce sulphur to impalpable dust. We may mix these in any proportions, but the microscope will show us each particle of iron and of sulphur unaltered. But now make a heap of the mixture, and apply flame to it: it grows suddenly red hot—sure sign of *chemical* mixture or combination—and forms a black mass, altogether different from both the elements which have now chemically combined. The remarkable thing is that *this* sort of mixture only and always takes place *in certain proportions.* In this case, if all uncombined iron or sulphur be carefully separated, 56 grains of iron will have combined with 32 grains of sulphur—neither less nor more. A more wonderful fact still has been discovered. By many careful experiments the "combining weights" of all the elements with each other have been ascertained; and it has been found that for every combination with *any* other element, the combining weight of the same element remains the same. If 32 grains of sulphur combine with 56 grains of iron to form a distinct substance, and 16 grains of oxygen gas also combine with 56 grains of iron to form another substance, then 32 grains of sulphur will also combine with 16 grains of oxygen. So on with every other element. Sulphur and iron will combine with other proportions of oxygen as well, but then these other proportions are all *multiples* of the 32 or 56 or 16 respectively; and so every combination of any element consists of some multiple of its proper proportionate weight compared with that of the other substance. It is almost impossible to resist the conclusion that each unit or ultimate particle of any "element" of matter has its own proper, individual, specific proportionate weight, and that these facts are explained on the supposition, that in every chemical combination one or more units of one combine with one or more units of the other.

We have a great test of such a hypothesis. If it be well founded, could we combine the units by *counting* them instead of *weighing* them, then the proportions would be very much simpler. Now, we can do this by mixing substances which are in the state of gas or vapour. Different substances, while in the fluid or solid state, expand very differently for the same degree of heat; but when in the state of vapour, all substances expand alike for the same increase of what is called "absolute temperature," and contract alike for the same increase of pressure. We know that vapour occupies enormously more space than fluid or solid matter—a cubic inch of water expands into a cubic foot of steam—and the inference naturally is that its particles are much farther apart, so far that they have lost their power of cohesion, and only obey general laws of heat and pressure. Moreover, into the cubic foot of steam we can evaporate, in addition, just as much alcohol vapour as if the steam were not there; and then, thirdly, into the same space as much ether vapour as if neither other vapour were there; showing that there must be vast interstices between the particles. From these facts, and some others, it can be almost proved mathematically that equal spaces, occupied by different substances in the state of gas or vapour at the same temperature and pressure, contain the *same number of molecules*, or separate smallest units which give the vapour or gas its character. It follows that to measure equal volumes, is to count equal numbers of these units or molecules. Now, it is found that all chemical substances, when in the state of gas or vapour, combine chemically in *simple volumes.* By weight, one part of hydrogen combines with sixteen parts of oxygen to form water; by measure, both being gases, we take two volumes of hydrogen and one of oxygen. Sometimes substances in a state of vapour mix in equal volumes, sometimes two to three, etc., but the proportion is always simple, just as we should expect. Not only so, the combined product, if measured in a gaseous state, also maintains a simple proportion, being usually *two* volumes, however many volumes one of the combining gases may be. The two volumes of hydrogen and one volume of oxygen do not make three volumes of steam, but two.

Again, therefore, we are forced to distinguish between two sorts of the units of matter. The smallest unit that can exist separately of any sort of matter, simple or compound, so as to exhibit its separate properties, we call a *molecule.* But the ultimate unit of any simple element, to which belongs its specific weight, and one or more of which combine with one or more units of some other element to form another substance, we call an *atom;* and we reckon the specific or atomic weights of all atoms with reference to that of hydrogen, which is the lightest body in nature. It may appear at first that every molecule of an "element" must be the same as its atom; and were this so the atomic weight of every element would be simply its specific gravity (in vapour) compared with hydrogen gas. But this is not so. By checking numerous combinations against each other, it is found that the smallest volume of hydrogen found in combination with other substances is only half the smallest volume which can be obtained as a residue of hydrogen by itself. It follows that two atoms of hydrogen combine to form one *molecule* of hydrogen as hydrogen, although one single atom can combine with other atoms. The same is true of many other elements, so that in their case the molecular weight is not the same as the atomic weight.

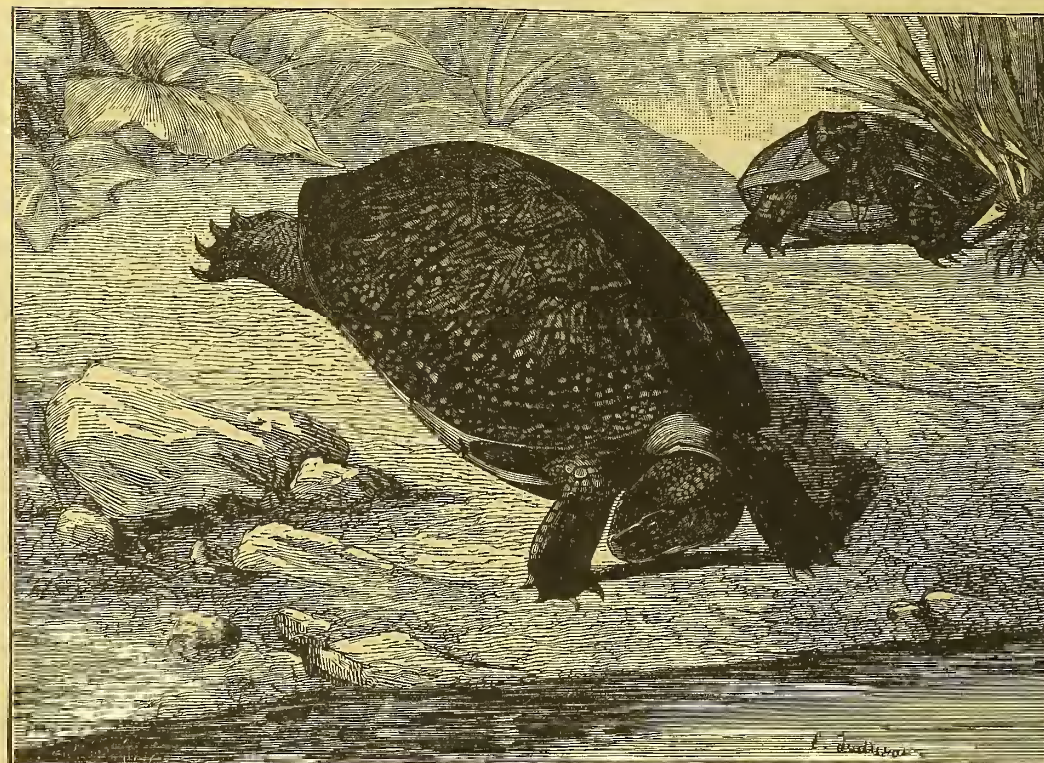
In this brief preliminary survey of the subject, we have only finally to consider the solid, liquid, and gaseous states matter may assume. In a gas the molecules are at great comparative distances, though in reality very small distances, and are moving at tremendous velocity. In their motions they encounter each other, rebound, and so change the directions of their motions, being supposed to be of infinite elasticity; but the average bombardments upon the containing surface are equal, and determine the pressure of the gas. The velocity of their motion constitutes the temperature of the gas, and hence we see why an increase of heat increases the volume or the pressure, or may even force asunder the constituent portions of molecules apart into atoms. In liquids, on the other hand, the molecules are nearer, so that cohesion affects them: hence they do not fly off into space as gas would do if unconfined. Yet they can move amongst themselves, and do move: hence a little colouring matter of the same specific gravity diffuses through a whole mass of liquid. Here, again, heat applied to a liquid may increase the molecular motion so much, that molecules fly off out of the sphere of attraction, when we say they "evaporate." Lastly, in solid bodies, the forces of cohesion are so strong as to prevent free motion, but the molecules still move rapidly, though preserving the same relative position; that is, they *vibrate* about a fixed point. Here, again, an increase of heat, which simply means an increase of this molecular motion, necessarily leads (as a rule) to expansion of the solid body, since it must increase the distance between its molecules.

Such are the modern conceptions respecting the general structure of "matter." So far there seems nothing very mysterious about them, or difficult to conceive. Before we can understand where the inscrutable mystery really lies, we must consider a little further the wonderful relations between atoms and molecules, which we will do in another paper.

TORTOISES.

TORTOISES rank certainly amongst the most curious groups of the reptile world. Their peculiarities have attracted popular notice, as their more scientific aspects have secured for them a large share of zoological attention. Enclosed in a bony box, from which head, limbs, and tail protrude, the tortoises, and their neighbours the turtles, form an interesting study. In considering these animals two ideas may animate us. The first theory of their structure is that they are built up, as regards their bodily form, on special lines, such as are found in no other animals. The second idea is that which maintains that possibly, after all, tortoises and turtles may be only modified members of the reptile group. Whether, then, do they owe their peculiarities to absolutely new structures, unknown in other reptiles, or to modifications of ordinary reptilious bodies? This interesting question is easily answered. If we examine the skeleton of a tortoise, and look into the inside of its body, we readily see the spine, or backbone, forming the central beam, so to speak, of the animal's back. The spine, instead of being movable in the back-region, has its joints firmly ossified together. No movement is permitted between the separate bones, and the first great demand of the animal—namely, for stability of frame, is thus satisfied. The roof or back, itself, is formed of the ribs. These bones are greatly broadened out, and instead of being narrow bones, showing spaces between them, as in other animals, they are firmly united together. At the sides of the body we see a series of plates, or pieces, called *marginal plates.* Below, and lying next the ground when the animal walks, is found a great broad bony plate, which, of old, was believed to represent a breast-bone. We know, however, that in these animals no such bone is developed, and this so-called breast-bone, or *plastron*, as it is named, is found to be composed of bony elements similar to those we see in the marginal, or side plates. These latter are formed by the skin, and in one sense are therefore to be regarded as modified "scales." Outside, as we look at a living tortoise or turtle, we see the back to be covered with plates or scales. These also represent skin-formations; and from one species of turtle—the "hawk's-bill turtle"—tortoise-shell is obtained from the plates intermediate in nature between the tortoises and turtles; and some, such as the river and marsh tortoises of America, are as freely aquatic in habits as are the turtles.

The best known of the turtles are the Green Turtle, which serves as the basis of the well-known delicacy "turtle soup;" and the Hawk's-bill Turtle," already mentioned, and which affords "tortoise-shell." Of the tortoises, the common European tortoise, *Testudo Græca* (Fig. 1), is the



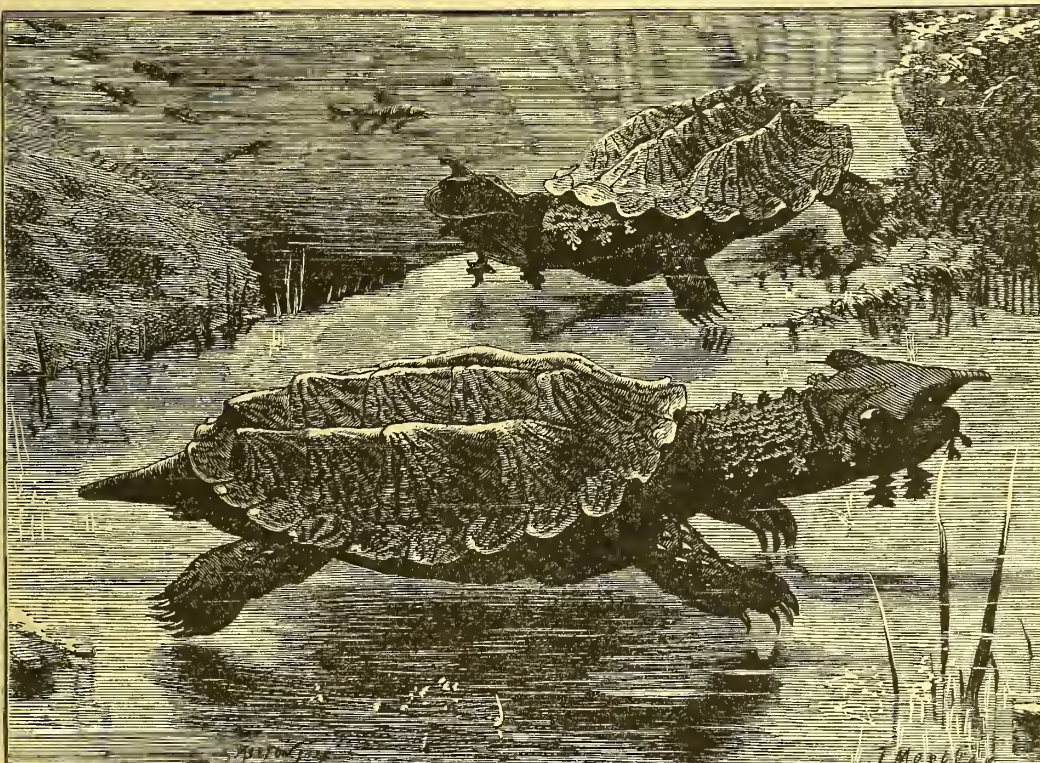
COMMON TORTOISE OF EUROPE (*Testudo Græca*).

in question. Sometimes, as in the "soft turtles," the back may be covered with a leathery skin instead of scales. The whole body of a tortoise is thus seen to represent simply a modification of an ordinary reptilian type. The body is that of a reptile, modified and altered in a curious fashion to suit the life and habits of the animals which exhibit it.

The tortoises differ from the turtles in having bodies mostly of square shape, and of arched form, whilst the head and limbs can be withdrawn into the "shell." In the turtles, the head and limbs cannot be thus withdrawn; the body is oval and flattened, and the fore limbs are longer than the hind limbs. The feet in the turtles are, moreover, adapted for swimming, whilst those of the tortoise are fitted for walking. Certain forms appear to be most familiar form. As a garden pet this animal, which inhabits the Mediterranean borders, is too well known to require description. The *Matamata*, figured in our second illustration, is one of the most curious and weird of the tortoise race. It is found in South America, and belongs to a group of tortoises which possess flattened heads and mobile necks. The feet are webbed, clearly indicating an adaptation to an aquatic life. The flesh of the Matamata is so highly esteemed that a scarcity of these animals is now threatened from the rapidity with which their numbers have been thinned. When full grown, this animal attains a length of three feet. The most singular feature of the Matamata is its head. The head itself is much flattened, and a curious sharp-pointed snout exists.

Above, the head bears two curious appendages, resembling ears, and below the chin are two similar projections, whilst the throat also possesses four filaments. The neck is further tufted in like manner, and a short tail is developed. The shell itself is keeled, the scales or plates which cover it having sharp edges. In habits the Matamata is carnivorous. It feeds on fishes, and other aquatic animals; and by aid of its powerful jaws is enabled to snap and mangle, in a very decided fashion, any prey which may come in its way.

to say the least, highly singular that in the Eastern legends frequent reference is made to the tortoises as possessing a share in the building of the world. The Hindu theory that a great tortoise lies beneath the earth, and keeps it from sinking in the sea, is familiar enough. It may thus be probable that these legends date from a far-back period, when the primitive tenants of the Eastern lands may have beheld in the flesh, and been contemporaries of, the great tortoise whose remains we find in a fossil state to-day.



THE MATAMATA TORTOISE.

If the tortoises of the present thus include in their ranks not a few strange creatures, the same remark holds good of the tortoises of the past. Fossil tortoises possess a history equally curious with that of the living members of the group; and it is remarkable that, as the ancient geological *strata* show us how both mammals and saurians formerly existed in gigantic forms, so it is also with the class of animals before us. In the recent deposits of the Himalayas the remains of a giant member of the tortoise race have been found. This form has been named the *Colossochelys Atlas*. In length this large animal must have measured at the very least twenty feet. It is,

STORAGE OF ELECTRICITY.

A FEW months after the invention of the Voltaic battery, two important discoveries were made as to the behaviour of the current which it afforded. The first of these was that the current was capable of decomposing water into its two constituents—oxygen and hydrogen. The apparatus by which this can be done is of simple construction, and is called a voltameter (Fig. 1). It consists of two inverted tubes standing in a glass cup. Underneath the open end of each is placed a strip of platinum foil, which form electrodes when placed in connection with a battery. Both tubes and cup are filled with acidulated water, and when the circuit is complete decomposition commences. Bubbles of gas are given off from both electrodes, and as they rise in the tubes the water is displaced, and sinks into the cup. One tube fills with gas at double the rate that the other does, and the contained gas can easily, by a simple test, be proved to be hydrogen. In the other tube is just half the volume of oxygen.

The other discovery with which we are here concerned is founded on the last. In 1801 Gautherot found that the two platinum electrodes, after being used in the manner described, possessed the property of furnishing a transient current on their own account, forming, as it were, a Voltaic cell. The current so given was small, but it was sufficient to cause muscular contractions in a frog's leg, and could easily be detected when the wires were placed above and beneath the tongue. This secondary current, as we may term it, was always found lo be in the reverse direction to the primary, which gave it origin. Later researches pointed out that this curious reaction actually commences before the primary current is broken; and in the first forms of batteries made, before it was understood, their performance was seriously affected by this opposing force. Under the term "polarisation" the reaction is now familiar to all battery-makers, and many ingenious plans have been adopted to nullify its effects.

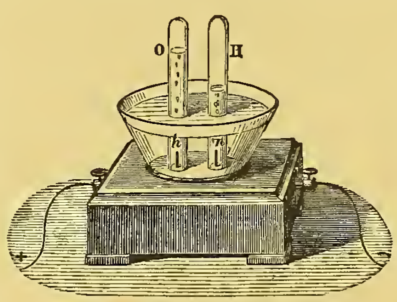


Fig. 1.—VOLTAMETER.

The phenomenon of the secondary current obtained from the platinum electrodes can be explained by the curious property possessed by that metal of absorbing upon its surface the two gases which have been separated from the water. These gases form a film upon the surface of the metal, that to which hydrogen adheres behaving towards clean platinum somewhat like zinc, or other metal which is easily oxidised. Towards platinum which has absorbed a film of oxygen it exercises a still greater electromotive force, and we may say that the energy which has been spent in tearing the water asunder to produce these gases is stored up in them.

Grove's gas battery, which is figured in most physical treatises, consists of what may be described as a row of voltameters, the hydrogen tube of one being connected with the oxygen tube of the next. It was charged by an electric current of sufficient power to overcome the affinity of the gases combined in the water, and these gases separate into the tubes, as in the case of the simple voltameter. But in the compound arrangement the secondary current was of great power, and with a battery of fifty cells a small electric light could be produced. It will, however, be seen that such a contrivance, with its hundred glass tubes and acidulated water, requiring most delicate manipulation, however valuable it might be from a philosophical point of view, was quite useless in any other way. Indeed, it may quite safely be assumed that its inventor constructed it more as an interesting experiment than for any more definite purpose.

In the year 1860 we find the first record of any attempt to make secondary currents of sufficient strength to be useful, and this year may be regarded as that in which the storage-battery was born. To M. Gaston Planté must be given the credit of making the practical discovery. Not content with merely repeating the experiments of others, he used many different metals for his electrodes, noted their behaviour when exposed to the electric current in different liquids, and finally, as a result of these experiments, pointed out that the most marked effect was produced when lead was treated in dilute sulphuric acid. The so-called polarisation, which had so often formed a stumblingblock to the electrician, was encouraged by M. Planté, in order that he might turn it to practical account. Each cell was composed of a tall glass cylindrical vessel, full of dilute sulphuric acid. In this liquid are immersed two leaden plates, arranged so as to expose as much surface as possible, and at the same time to be distinct from one another (Fig. 2).

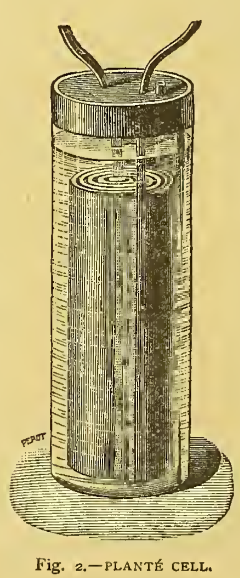


Fig. 2.—PLANTÉ CELL.

This is brought about by rolling together two long strips of sheet lead, inserting between them a layer of coarse cloth. (This, later on, was superseded by strips of gutta-percha, which fulfilled the same office.) From the exterior end of one sheet, and from the interior end of the other, a little strip of lead is carried to the outside of the containing-vessel, for ready attachment to a battery.

The cell as thus made is by no means ready to furnish a secondary current, except of a very transient and feeble kind. When an ordinary battery is attached—say, three or four cells of Bunsen or Grove—the separated gases bubble up from the surface of the lead plates, but very little film is formed on their surface. As the operation of charging progresses, the leaden plate by which the current enters is acted upon by the oxygen, and becomes covered with a layer of peroxide of lead, and this layer behaves towards the other lead plate, with its hydrogen film, much in the same way that the oxygenised platinum in the Grove gas battery acted towards its neighbour. When the charging-battery is detached the cell will now yield a secondary current, and as it does so the brown peroxide is reduced to the metallic state, which assumes on the surface of the lead a curious spongy form. The cell is now recharged, but in the opposite direction, so that the other plate receives a coating of peroxide, and is afterwards reduced to a spongy condition. This charging and cross-charging is persevered in many times, with frequent intervals of repose, until both plates become eaten into by this spongy transformation to a considerable depth. At the end of some weeks they are in a condition to furnish the best results, and are said to be "formed." The charging, when required, must now be in one direction only, or there would be a risk of spoiling the cell.

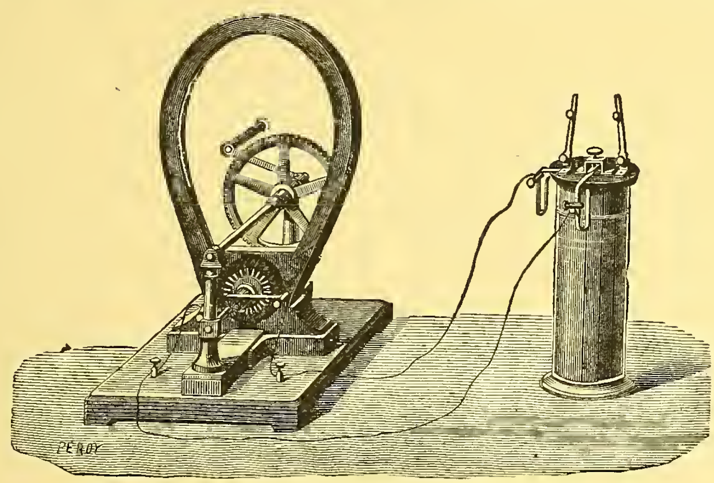


Fig. 3.—PLANTÉ CELL CHARGING FROM GRAMME MACHINE.

A properly-constructed Planté cell will retain its charge for some days, and when discharged will afford for a short time a very powerful current. Several cells joined up together, so as to form a battery, will give effects of proportionate power, and it is possible with twenty cells to exhibit an arc light for a few minutes. The charging must be accomplished with at least two Bunsens if a battery is employed, for the simple reason that the electro-motive force of the Planté cell is more than that of a single Bunsen; or a dynamo machine may be employed, as in Fig. 3. The secondary battery slowly accumulates the energy represented by the charging cells or machine; and although the operation of charging occupies some hours, we can, by discharging the Planté cell, utilise that accumulated charge in a few minutes. In other words, by using a secondary battery as the medium, we can for a short time obtain the power of thirty or forty Bunsen cells from two or three.

For more than twenty years the Planté cell has been available, and has figured in the price lists of dealers in electrical apparatus, but it has only been known to physicists and to a few surgeons, who have found in it a useful means of obtaining a powerful electric current of short duration. The storage-battery may be said to have had its first introduction to the general public two years ago, at the hands of Sir William Thomson. That gentleman wrote a long letter to the *Times*, giving an account of how he had brought with him by railway from Paris to Glasgow "a box of electricity." He describes it as weighing 165 lb., and having stored up in its mysterious recesses *two million foot-pounds of energy*, which had been put into it some days before at Paris. This letter, we need hardly say, caused immense sensation. Energy running to seven figures was, thought everybody, something very strong indeed; and "bottled lightning," and other such terms, were used by accomplished leader-writers. When this two million foot-pounds was found to accord with one horse-power for one hour, the box was not considered quite so wonderful, after all. Still, there was really something in it. The "box of electricity" was simply a modified Planté battery contrived by M. Faure, who very cleverly has hit upon a mode of shortening and also simplifying the "forming" of the lead plates. He does this by mixing red lead with dilute acid into a paste, and painting the surface of the plates with the mixture. This induces a rapid formation of that brown peroxide which in the Planté cell takes so long to form. But even in M. Faure's modified cell the process of charging is at first tedious, and the current from a dynamo machine must be sent through it for several days before it is capable of furnishing a return ; nor does it exhibit its full power until some weeks have elapsed. Of course, when once formed the operation of charging is accomplished in far less time—about half an hour with a dynamo machine—and as the current must not exceed in force that of the cells, it can be split up so as to charge a large number of cells at one operation. The red lead, during this operation, is reduced to the peroxide on the one hand, and on the other assumes the spongy metallic state.

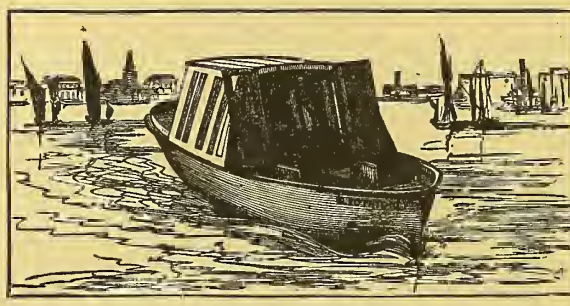


Fig. 4.—THE "ELECTRICITY."

The Faure cell takes the form of an oblong box, containing flat plates coated with a thick layer of red lead, each pl e being separated from its fellow by a piece of felt. The whole is charged with dilute acid. At first the cell was made of spiral form, but this has been superseded by that just described. Comparisons between the Planté and Faure accumulators have given rise to much discussion. The Planté, as we have seen, will give powerful effects for a short time—an invaluable property for certain services. The Faure is less rapid in discharge, and will, from the greater thickness of its materials, take in, and therefore yield up, a larger charge. Since the appearance of the Faure battery many inventors have been busy in the same direction. The Faure cell itself has been greatly improved, and, under the name of the Faure-Sellon-Volckmar battery, has lately come into extended use. Brush, in America, has patented a secondary battery ; De Meritens, in France, has done the same ; and a legion of less familiar names have followed suit. But to Planté and his great researches, extending over a number of years, is due the invention of the system ; and it is as well that, in reviewing recent modifications, this should not be lost sight of.

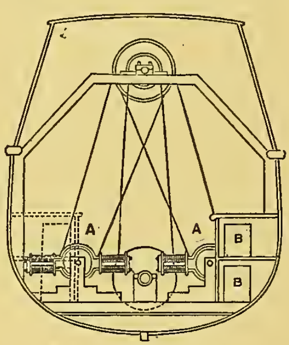
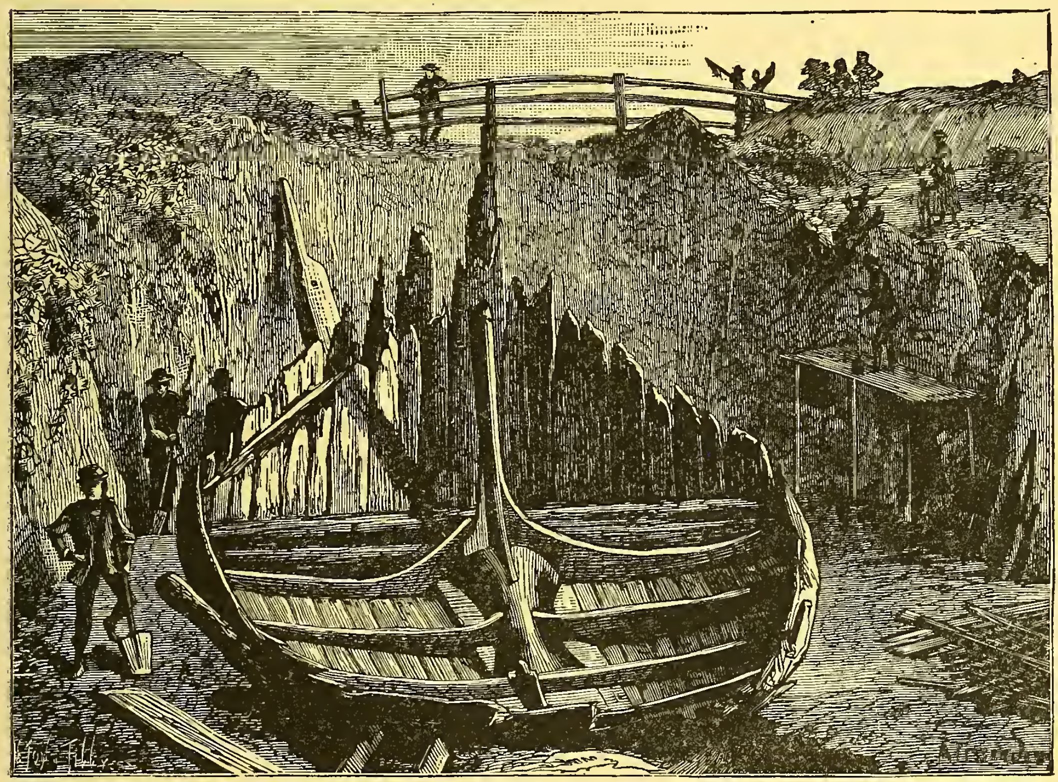


Fig. 5.—CROSS SECTION.

The first notable application of the Faure battery was to light up by the incandescent system the Pullman train, which runs between London and Brighton four times daily. These cells are charged by a dynamo for the day's work before starting on their first journey ; but as the system is gradually developed and improved upon, it will be possible to charge them as the train runs along, by a dynamo in connection with the axle of one pair of wheels. The next application, which caused much interest, was the propulsion of a launch upon the Thames, named the *Electricity* (Fig. 4). This launch carried two Siemens dynamo machines, shown at A A in Fig. 5, one of which was geared to the screw-propeller, or both could be driven by the same current. The latter was furnished by forty-five accumulators of the Sellon-Volckmar pattern, stowed away under the seats in rows, as shown at B B. The forty-five cells, furnishing a good speed for six hours, were estimated to give an effective force of four horse-power. The launch is twenty-six feet long, five feet wide, and draws about two feet of water. Lastly, at Kew Bridge, an electric tram-car, owing its motive power to the same form of storage-battery, was successfully run. This tram-car raised hopes that the system may be placed on a commercial basis ; and we believe that steps have been taken to secure a licence from the Board of Trade for the establishment of a regular line of such cars in a London suburb. The rate attained was six miles per hour, and the cost was estimated at 6s. 3d. per day, or about one-fourth of the cost of horsing an ordinary car. The batteries, as in the case of the launch, were disposed under the passengers' seats, and besides furnishing the motive power, supplied the car with light.

But these applications, although most interesting, are insignificant when we review the marvellous number of services in which electricians believe the storage-battery can be employed. The tides in our rivers can—they tell us—be made to store up by day their energy (at present almost wasted), and to give it back at night as light. One-tenth part of the energy which flows along the Avon could, we are told, be made to light the city of Bristol. Boxes stored with electrical energy may in the time to come be brought to our houses every day, as regularly as we are supplied with bread or milk. The energy so charged we can use up as light, heat, or for motive power. This is what the electrician promises ; but we may assume that before this comes to pass the storage-battery must see several improvements. It is far from perfect at present, and many scientific men have pointed out that it is far from economical in use. They also assert that the power of storage is gradually lost as the battery is charged from time to time. It is, however, probable that this and other difficulties are not insurmountable. In fact some minor defect is being either ameliorated or remedied almost every month, and better results than at first are already obtained.



AN OLD VIKING'S SHIP.

AN OLD VIKING'S SHIP.

ON the rugged coast of Norway are found, as physical features of the country, immense arms of the sea which penetrate inland for from 60 to 200 miles. These are known as fjords, answering to, and having somewhat the same appearance as, the firths of North Britain. On the beach of one of these fjords there was discovered a few years ago a relic of the past which is of great interest, not only to antiquarians, but to every one who has read of the Danes, those hardy Norsemen whose ruling of the waves struck such terror to the hearts of all whose countries were bounded by the ocean.

The relic referred to rested beneath a mound, or tumulus, which had for many years excited the attention of antiquaries, more especially as popular tradition asserted that beneath the hillock rested the mortal remains of one of those kings who, some centuries back, ruled over different divisions of Norway. At last a number of workers were enrolled, and they proceeded to dig down into the "King's Hill," for such was the name by which the place was known. Their labours had a most successful result, and after several weeks' toil they laid bare the remains of a ship between 70 and 80 feet in length. This vessel had once belonged to one of those bold pirates of the sea, whose doings had caused that trembling appeal to be added to many an honest sailor's litany, "From the fury of the Norseman, good Lord, deliver us!"

The period to which this ship may be referred is the later "Iron Age, or Viking period," which may be placed between the ninth and eleventh centuries, A.D. At this time the custom of burning the dead, which once prevailed in Norway, had given place, among important personages at least, to burial in a war ship. Indications were not wanting to show that the ship discovered beneath the King's

Hill was one of these. Just behind the mast were the remains of the burial chamber, together with remnants of a bed upon which the body had rested. Bones there were none, for the excavators found that others had been before them (doubtless in search of treasure), and had for some reason removed them. But enough remained to reward the workers for their trouble, for they found, among other things, traces of a landing-stage, a number of kitchen utensils, wooden plates and drinking-cups, besides iron fish-hooks, and a number of miscellaneous articles.

The ship, although of wood, was in a marvellous state of preservation, owing no doubt to the character of the soil in which it had lain for 1,000 years. This soil was a species of blue clay, which by completely excluding moisture and air arrested decay. The hill was about 150 feet in diameter, and the ship was deposited within it standing on her keel, and decorated with shields hung close together along each side. One curious feature may be particularly noticed, as giving the origin of a word familiar to all, whose derivation might seem obscure. The rudder consisted of a board hung by a rope on the right-hand side of the stern-post—a customary way of hanging it which prevailed up to about the fourteenth century. From this steering-board we get the word "starboard," which still denotes the right-hand side even of a penny steamboat.

Our illustration will give a fair idea of the appearance of this Viking's ship when cleared of the surrounding earth. Although other relics of the kind have before been found in Norway, this is the largest, and from its perfect condition, by far the most interesting. It is now added to the store of various antiquities belonging to the University of Christiania. The good and thorough workmanship of the vessel is remarkable throughout, and could not be excelled in the very best of the wooden walls of old England.

To most people, the Danes and their affairs represent detached items learnt long ago at school, which have almost passed out of memory. Even in the estimation of childhood such events seemed to be too far away to have any reality about them. But here, when we look at this old vessel, we have at once a chain linking us with the past, and recalling to our minds the deeds of those bold freebooters who used to rule the main. We can imagine how this old sea-king, whose name has long been forgotten, chose this romantic spot for his sepulchre. The brave vessel which he had loved so well, and which had carried him through many a fight, and had weathered many a storm, was now to be his coffin. There his body was laid by his sorrowing followers, close to the shore, and ready once more to be launched on a new life whenever the summons came. In all these ancient methods of burial there appears the hope of a life to come.

MEDICAL SUPERSTITIONS.

ALTHOUGH the physician of to-day pursues his studies upon scientific principles, and builds up his theories with thoughtful care upon facts anxiously ascertained and verified, it was not always so. Time was when the grave doctor upheld his claim to dignity and learning upon no better foundations than those which supported the reputation of alchemy, astrology, palmistry, and all kinds of superstition and quackery. The great court physician, John de Gaddesden, who hung the room, bed, and window with scarlet cloth to cure small pox in a child of Edward II., and thought sending a patient to hear high mass in church would cure epilepsy, would be laughed to scorn as a quack by even the most ignorant quacks of to-day. Beating with a cane was once accepted as a sure cure for ague, and Galen recommended it as fattening! Gordonius thought such beating the proper remedy in certain cases of nervous irritability, and himself prescribed it.* Mayern, a famous French physician, who attended Henry IV. and Louis XIII. of France, and our English monarchs James I., Charles I., and Charles II., had great faith in the curative properties of pulverised human bones! and extolled the magic virtues of his popular gout powder, the chief ingredient of which was, the raspings of a human skull which had never been buried! He also had faith in such medical remedies as "adders, bats, sucking-whelps, earth-worms, hog's-grease, the marrow of a stag, and the thigh-bone of an ox." "To resist sorrow, and recreate the heart," the ancient doctors administered the hyacinth and topaz in some liquid, or hung them as amulets about their patient's neck. To free the mind and mend the manners, or disperse "black choler," the sapphire was precious as a remedy as well as a stone. A particular kind of onyx restored bodily vigour, and improved the general health! One learned physician made the wonderful discovery that in the body of the swallow existed a stone which he called chelidonius, and which, extracted, wrapped in "a fair cloth," and tied to the right arm, restored lunatics to their senses, and calmed raving madness! Dr. Bulleyn, a great physician in the reign of Queen Elizabeth, prescribed for a child afflicted by some nervous disorder "a smal yong mouse rosted!" For diseases of the lungs and coughs this same learned gentleman—he was a member of Queen Anne Boleyn's family—prescribed "snayles broken from the shelles and sodden in whyte wyne with oyle and sugar." Sir Kenelm Digby professed to cure wounds with marvellous rapidity in the following way:—A piece of the apparel worn by the wounded person, stained with his blood, was dipped in water in which one of the learned man's

* See article on "Flagellation," p. 259.

"sympathetic powders" had been dissolved! For blood-spitting, Dr. Hancoke very strongly recommended stewed prunes, which he also prescribed for curing other serious ailments. Nor are later times without such extraordinary beliefs, as witness Sir William Read, Monsieur Thibaud, Dr. Simon Forman, and other astrologer-physicians of the 17th century. At a later date, Henry Fielding and Bishop Berkeley, as well as many medical men all over the country, were firm believers in the medical virtues of tar-water as a great remedy for all kinds of diseases.

The medicines of our Anglo-Saxon ancestors were largely botanical, but many were extraordinary and eccentric enough to move our wonder. A favourite remedy was bull's dung in hot water. This was used for a large number of minor complaints. Stones from the maw of young swallows, provided they were little, and after removal had been carefully preserved from contact with earth, water, or other stones, were used for pains in the head or eyes, typhus, nightmare, evil dreams, enchantments, and temptations, &c., three being a dose. Whipping with a whip made of porpoise-hide was a cure adopted for lunatics. Stolen turnips were regarded as a cure for cripples. The hot blood of a sheep was a preventive in cases where a person had inadvertently swallowed any foul creeping thing. Wives were recommended to take, as extremely beneficial, an occasional sup or two of their husband's blood. Sealskin soles to the shoes drove away gout, they said. To cure the bite of "hunting spider," the patient was instructed to make five wounds, four round it and one on it, collect the blood in a spoon, and silently throw it over a main road or "waggon-way." To deprive wolfsbane of its consequences when swallowed, the patient's legs were held above his head, and numerous cuts made in them, out of which the poison would, they said, escape without injuring the patient. To cure tooth-ache, a candle was made of acorn mead, henbane seed, and white wax. While this was burning the patient had to hold his head under a black cloth with his mouth open above the flame, so that the "little worms" causing the pain might be suffocated, and fall out from the teeth. A more violent remedy to be adopted in the event of this one's failure was to say, "Argidam, margidam, sturgidam," expectorate into the mouth of a frog, and drive it away from the house door. A mixture of yellow ochre, rock-salt, and pepper in equal parts, strained through a cloth, was recommended as an eye-salve. Swollen eyes were to be cured by placing on the neck a live crab with its eyes put out, taken from water. For the bite of a mad dog you should remove from under his tongue the worms to be found there, and take them after you had led them "round about a fig-tree." To escape stomach-ache, it was advised that on rising every morning, you should put on your left shoe first. Boar's suet seethed in water, and mixed with boar's foam was, according to Anglo-Saxon leechcraft, a sure remedy for sickness. For weakness of the joints, the water in which a living fox had been seethed until nothing remained but its bones, was an excellent medicine. Excessive drowsiness was to be cured by drinking wine in which a hare's brain had been put. The lung of a ram was a remedy for ulcers, and the flesh of a lion was good for persons "suffering apparitions." For low spirits, a radish, eaten with salt and vinegar, was prescribed. To get rid of warts you were to write on seven little wafers, the following seven names: Maximanus, Walchus, Johannes, Martinianous, Dionysius, Constantinus, Serafion, and sing a certain odd-sounding incantation, first into one ear and then into the other, and then above the patient's poll, after which a virgin was to hang the incantation round the patient's neck. This cure is described as a wonderful one.

The Chinese boast works on medicine three thousand years old. They divide their remarks under the heads of healing, cooling, refreshing, and temperate. They embrace most of the known medicines, together with mineral waters. Fire is an agent in which they profess to have great faith, and the *moxa* is recommended in almost every ailment. Animal magnetism is also practised. Their physicians' prescriptions are classified under seven heads:—1, the great prescription; 2, the little prescription; 3, the slow prescription; 4, the quick prescription; 5, the odd prescription; 6, the even prescription; 7, the double prescription. These are applied under special circumstances and conditions, which, in their turn, are classified.

The medicinal measures adopted by the priests of Greece were not less extraordinary, and the results credibly recorded to have followed them in some instances show the power of strong belief, which has been similarly shown in many modern cases. Caius, who was blind, was cured by carrying out the instructions given by the oracle. He went to the temple, prayed fervently, crossed the sanctuary from right to left, placed five fingers on the altar, and covering his eyes with them, was instantly restored to sight. On another occasion the oracle commanded a blind soldier named Valerius Apes to make an ointment by mixing honey with the blood of a white cock, and anoint his eyes with it for three consecutive days. This restored his sight, and he returned public thanks to the gods. Another case was that of Julian, who was spitting blood and fast nearing death, when the oracle instructed him to take from the sacred altar some seeds of the pine, and eat them mixed with honey for three days. He did so, was cured, and offered up prayers of gratitude in the presence of the priests and people.

ICE HOTTER THAN BOILING WATER.

In an article upon "Frost Explosions," it was shown by a very simple experiment how the melting-point of ice was lowered by pressure, so that a wire stretched by weights over a block of ice gradually melted its way through (see p. 288), the ice freezing together again as the pressure was removed. In another article (p. 15) reference has been made to the fact that the boiling-point of water is also affected by pressure. This is so to such an extent as to lead to some very extraordinary consequences, which were first experimentally demonstrated by Mr. Carnelly in 1880.

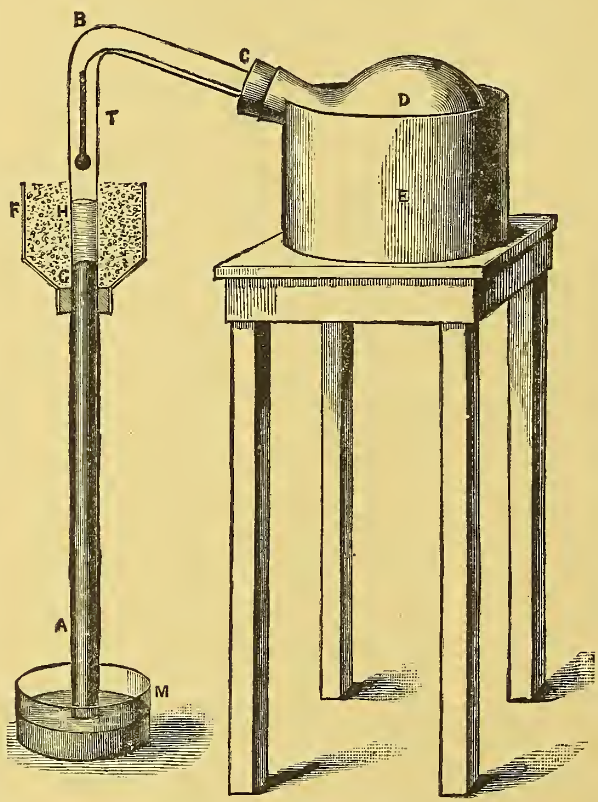


Fig. 1.—APPARATUS FOR HEATING ICE.

To understand these experiments we must consider what boiling water really means. Water is converted slowly and insensibly into vapour, at temperatures far below boiling; but the process is slow and tedious, because the expansive force of the vapour is counteracted by the pressure of the atmosphere. The expansive force is, however, increased by heat until it is able to overpower that pressure, and then the water "boils." If we increase the pressure, therefore, the vapour has a much greater force to overcome, and the water will not boil till it is heated far above the ordinary boiling-point. But in making such experiments a very singular fact was discovered—viz., that as the pressure was raised the corresponding advance in the boiling-point becomes less and less, until at last no increase of pressure is able to raise the boiling-point any more. If, therefore, we heat steam *above* that point, called the critical point, and which is about 774° Fahrenheit, the most tremendous pressure is unable to reduce it to a fluid state. The same applies to all other substances capable of assuming the gaseous and liquid states; and that is the reason why what were called the "permanent gases" resisted all attempts to liquefy them by pressure alone. Their critical point happens to be a very low temperature indeed, very far below that of ice; but when they were thus cooled as well as compressed by Cailletet and Pictet, they yielded and became liquid. We thus learn that for every substance in a gaseous state there is a temperature, above which the liquid state is absolutely impossible. It may be compressed into a space as small as the liquid form would occupy, possibly into less; but liquid it will not and cannot become.

The phenomena are equally remarkable if we examine the conditions under which the liquid form is assumed from the solid state; and it is strange that this also depends upon the boiling-point. As we reduce the pressure, the boiling-point falls with it. But naturally, as we have seen that with high pressures the boiling-point gradually rises *less and less*, until at length the "critical point" is reached; so with low pressures the boiling-point falls *more and more* with equal diminutions of pressure. It follows that at some given low pressure the boiling-point must fall below the melting-point of the substance; and when this point is attained, therefore, again the substance *cannot be liquefied*. There is, therefore, for every form of matter, a "critical temperature," above which no pressure will liquefy it; and at the other end of the scale a "critical pressure," below which no amount of heat can liquefy it, but must simply convert the particles of the solid, still dry, directly into vapour.

These remarkable facts are readily tested in various substances whose critical temperatures or pressures are very manageable. Camphor and iodine melt very easily, but their critical pressure is not much less than that of our atmosphere. If, therefore, either be heated in a vessel connected with an air-pump till they are fairly melted, and even begin to boil into vapour, a very slight rarefaction reduces them at once to a solid state, and no heat will then melt them while the pressure is kept low. On the other hand, arsenic cannot be melted in the open air, because its critical pressure is greater than that of the atmosphere; but if the air be condensed and heat is applied under pressure, it melts readily. It follows that if we could maintain and keep a perfect vacuum, where the pressure would be absolutely nothing, no substance could be liquefied at all, but must exist either as a solid or in the state of gas.

The most remarkable demonstration of these curious facts was accomplished by Mr. Carnelly in the case of ice. The critical temperature of H_2O (water) we have seen to be 774°; its critical pressure is found to be about that represented by one-fifth of an inch of mercurial pressure in the barometer, or about $\frac{1}{150}$ the pressure of our atmosphere. If we keep the atmosphere round ice distinctly below that pressure it must be impossible to melt it, whatever the amount of heat applied, but the molecules will fly off "dry" directly into steam. Now, it is easy enough to get a vacuum much below this with a common air-pump, but the steam is generated from the ice so rapidly that it is impossible in this way to maintain it: the steam creates pressure a great deal faster than the pump can keep it down. Mr. Carnelly was therefore obliged to use other means, and resorted to rapid condensation of the steam by intense cold in what is called a Torricellian vacuum, or space left empty by the subsidence of mercury to the barometrical height in a proper vessel.

The diagrams explain this beautiful experiment. The tube A B C (Fig. 1) is about an inch in diameter, four feet long from A to B, and open at the bottom. At C it is fitted by a tight india-rubber cork well sealed with wax, or otherwise, into the large flask or condenser D, which can be entirely embedded in a freezing-mixture of ice and salt contained in the vessel, E. A thermometer, T, is hung by a wire in the centre of the upper part of the tube, A B. All this being arranged the tube and flask are completely filled with mercury, from which all air has been expelled, when the end A is closed by the thumb and plunged into the bath of mercury, M. Of course, on removing the thumb the mercury falls to the point G, or height of the barometer, and by tilting the tube and flask all the mercury is run out of the latter and a Torricellian vacuum obtained. A tin case, F, filled with a freezing-mixture of pounded ice and salt, and fitted with an india-rubber or cork ring at the neck, so as to slide tightly on the tube, is then adjusted so as to surround the space at the top of the tube, and some water boiled to expel air is introduced into the tube at A, whence it passes up through the mercury, being lightest, till it forms a column G H, about two inches deep, over the mercury. The vessel, F, is also filled with the freezing-mixture. All vapour given off from the water is now condensed in the flask, D, as fast as it is formed, and in this way the pressure is kept down to about one-twentieth of an inch of mercury, or less than what is required. It takes usually about a quarter of an hour before the flask D is cold enough to effect this, which may be known by the height of the mercury in the tube A B; and by this time the column of water, G H, has congealed to a mass of ice.

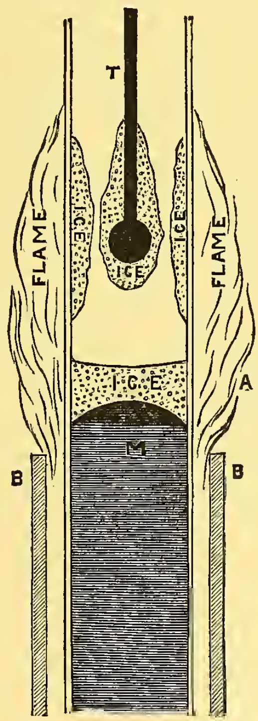


Fig. 2.—HOT ICE

Thus has been obtained the main condition of the experiment, viz., ice under very low pressure—less than the "critical" pressure—with provision in the large condenser for maintaining this. The case F, with the freezing-mixture, is now slid down the tube A B quite out of the way, and a Bunsen gas-burner, which has been kept round the upper part of the tube, is brought down so that its flame may surround the column of water, G H, and lighted. This arrangement is shown at Fig. 2, where BB is the top of the Bunsen burner, and M the top of the column of mercury, and T the thermometer, suspended some distance over it in the upper part of the tube. At first the ice melts as usual, chiefly at the bottom of the column, because the first steam formed cannot escape, and so creates pressure. The liquid thus formed also boils violently, owing to the low pressure above. When most of the ice has been melted, as at A, the Bunsen burner is extinguished, and the column of water tightly clasped by the hand, the heat of which, owing to the low pressure, is enough to make it boil so violently as to splash up the tube, where it freezes on the sides and upon the bulb of the thermometer, T. The Bunsen burner is then re-lighted, and the flame applied rather higher than before, when the ice at first again slightly melts next the tube, owing, as at first, to the pressure of the steam; but as soon as this finds a free vent at the top, *all fusion ceases*, and the ice on the thermometer and sides of the tube remains solid, however great the heat applied; it merely evaporates into steam without melting, so long as the steam condenses in the receiver with sufficient rapidity. The chief point in the experiment is to keep the ice from gathering too thickly, so that the steam may have free vent into the receiver; too great a mass creates pressure, and causes fusion by confining the steam between the ice and the tube.

In some of Mr. Carnelly's experiments the thermometer whose bulb was covered with dry ice indicated a heat as high as 356°, much above the heat of boiling water; and yet no sign of melting could be observed. To obtain this high temperature the heat applied must be very great, or it is all absorbed in converting the ice into vapour. From the degree in which water was warmed by dropping into it the "hot ice" off the thermometer-bulb, it has been calculated that the ice itself must have been raised to a temperature of 40° Fahrenheit above the heat of boiling water.

It must be remembered that the results of this startling experiment were all predicted beforehand from the considerations pointed out at the beginning of this article. It will be seen also that a fluid condition would be absolutely impossible for any substance in a perfect vacuum, and that it requires and presupposes *some* pressure, however small, of vapour or gas.

LEAF-INSECTS.

IN a previous article we noticed some remarkable cases in which insects of various groups present a more or less close resemblance to the twigs and smaller branches of trees. The most striking of these, the so-called "Walking Sticks" of the orthopterous family Phasmidæ, and especially the wingless species and the larvæ of those which finally acquire wings, were shown to be so stick-like in appearance as to deceive not only human eyes, but even to escape recognition by the much sharper senses of other animals. Imitation of the parts of plants is not, however, confined to these insects; and if they so faithfully represent the stems and twigs of shrubs, there are others which may serve to clothe them with an equally good imitation of foliage.

The most remarkable of these "Leaf-insects" are found only in those warmer parts of the globe which are inhabited by the "Walking Sticks," and the forms occurring in temperate climates generally mimic only dead and dried leaves. Thus many of the small moths belonging to the group of Tortrices, or "Leaf-rollers" as they are often called, offer a deceptive general resemblance to withered leaves; and a not uncommon British moth of another group, namely, the Oak Lappet Moth (*Gastropacha quercifolia*), in which the hind wings have the edges notched and projecting a little on each side beyond the fore wings when the latter are closed, might easily be mistaken for a small bunch of dead oak-leaves. There is no need to multiply instances, but every collector of Lepidoptera must be familiar with a host of moths which, without *specially* resembling any particular leaves, yet, when in repose, escape observation from their general form usually, and the similarity of their prevailing brownish tints to those of withered leaves.

Many of these moths, such as the well-known Yellow and Red Under-wings, have the hinder wings brightly coloured; but when at rest these are completely concealed by the dull-tinted fore wings which cover them. In the butterflies, which carry their wings upright in repose, this arrangement is manifestly impossible; and we find that protection is given to them by the dull colouring of the under side of the wings, this being the surface most exposed when the insect is resting from its flight. Thus, the common and highly-coloured Peacock, Painted Lady, and Tortoiseshell butterflies show chiefly different shades of brown on the lower surface of their wings.

Among tropical butterflies there are, however, some which not only exhibit a colour-resemblance to dried leaves, but also mimic them in a most remarkable manner in other respects. Two especially, belonging to the genus *Kallima*, one common in India and the other in the Malayan region, and therefore in localities where "Stick-insects" abound, furnish most singular examples of this kind of mimicry. These butterflies are of considerable size and strikingly coloured, showing on the upper surface a broad orange band on a deep bluish ground. The under surface, according to Mr. Wallace, who had many opportunities of observing these insects in the Eastern islands, "is very variable in colour, so that out of fifty specimens no two can be found exactly alike, but every one of them will be of some shade of ash, or brown, or ochre, such as are found among dead, dry, or decaying leaves. The apex of the upper wings is produced into an acute point—a very common form in the leaves of tropical shrubs and trees—and the lower wings are also produced into a short narrow tail;" so that when the wings are raised perpendicularly over the back in repose, they present exactly the form of a sharp-pointed leaf with a short, slender footstalk. The resemblance is increased by a dark curved line, which runs directly from the sharp point to the footstalk-like tail, and from which a few oblique lines are given off on each side, the whole closely reproducing the midrib and side veins of a leaf; and, what is still more extraordinary, the surface is blotched and marked in such a way as to produce the impression that the insect is not only a dead leaf, but a dead leaf which has been attacked by mildew.

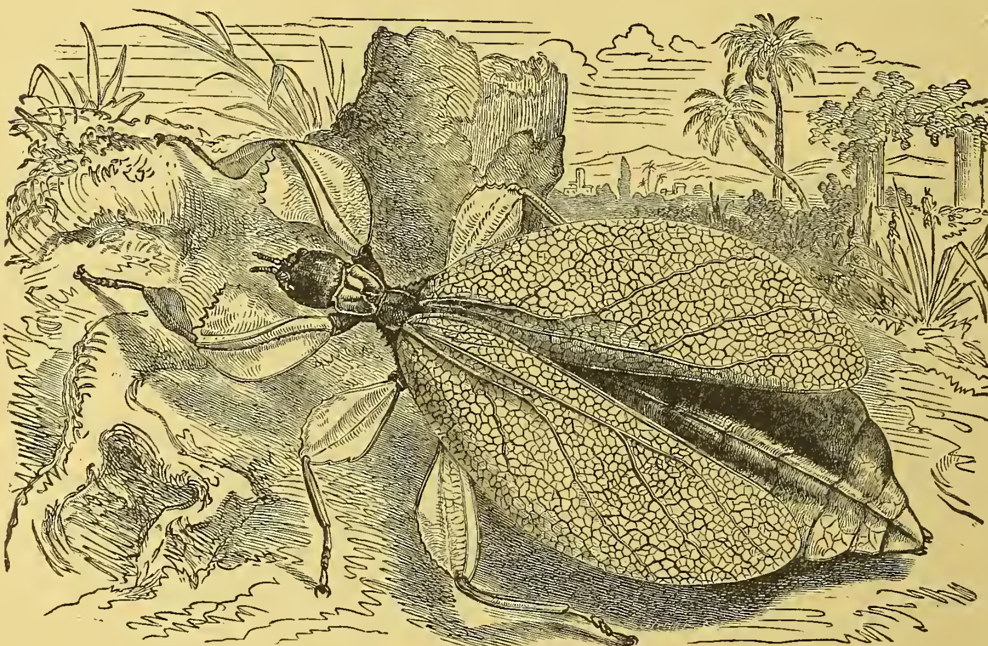
The mode in which this remarkable mimicry acts for the protection of the butterflies cannot be better indicated than in Mr. Wallace's own words. The insects, he says, "frequent dry forests, and fly very swiftly. They were never seen to settle on a flower or a green leaf, but were many times suddenly lost sight of in a bush or tree of dead leaves. On such occasions they were generally searched for in vain, for while gazing intently at the very spot where one had disappeared, it would often suddenly dart out, and again vanish twenty or fifty yards farther on. On one or two occasions the insect was detected reposing, and it could then be seen how completely it assimilates itself to the surrounding leaves. It sits on a nearly upright twig, the wings fitting closely back to back, concealing the antennæ and head, which are drawn up between their bases. The little tails of the hind wing touch the branch, and form a perfect stalk to the leaf, which is supported in its place by the claws of the middle pair of feet, which are slender and inconspicuous. The irregular outline of the wings gives exactly the perspective effect of a shrivelled leaf. We thus have size, colour, form, markings, and habits all combining together to produce a disguise which may be said to be absolutely perfect."

We can hardly call attention to any other example of leaf-mimicry so striking and extraordinary as the above; but a good many insects belonging to the same order as the Walking Sticks (the Orthoptera) display a very remarkable resemblance to leaves, in these cases generally to green foliage. Thus the animated twigs and the leaves to clothe them are somewhat nearly related—nay, in many instances those insects which were Walking Sticks in their younger stages, put on a leafy mimicry when they arrive at maturity, and thus, as it were, play both parts. The wings developed by these insects—at all events in the case of certain known species—present much resemblance to the leaves of the tree on which they habitually live, and thus the creature when resting, with its legs stretched out, has almost exactly the appearance of a small tuft of leaves like those surrounding it. Professor McCoy has quite recently described a large South Australian species under the name of *Tropidoderus rhodomus* (which may be translated the "Red-shouldered Keel-back") which, when at rest, he says, "agrees so nearly with the foliage of the *Eucalypti* on which it rests, that the sharpest eye would miss it;" while the lower surface of the leathery part of the wings is of a bright scarlet colour, which is also the tint of the under side of the *Eucalyptus* leaves.

These leafy Stick-insects of the family Phasmidæ show great varieties of form, and in many cases become more or less flattened, leading by degrees towards the creatures which are generally known as Leaf-insects or Walking Leaves. These curious animals, of which over fifteen species are known, are inhabitants of the East Indies and of the islands of the Eastern Archipelago, but extend their range as far to the west as the Seychelles Islands, and as far south and east as Mauritius and the Fijis. They have a more or less flattened leaf-like body, with a rather slender head and thorax in front representing the stalk of the leaf, and during their earlier stages they so completely represent a rather thick green leaf, as to be quite undistinguishable as they cling among the foliage of their favourite trees or shrubs. Curiously enough, the thighs and often some other parts of the legs are also dilated and leaf-like, and this seems to aid in the deception. On arriving at maturity the males, which are lighter and more slender than their partners, acquire a pair of fan-like hinder wings, with the usual leathery front border, and a pair of short fore wings which cover the bases of the former. The female, which is considerably larger and broader than the male, has no hind wings, but the fore wings are enlarged to such an extent as nearly to cover the whole of the abdomen, and in their structure they present in several cases the most singular resemblance to true leaves that can be met with in the insect world, showing, when brought close together, a representation of the midrib passing down the middle, and giving off on the two sides the ordinary diverging veins, from which again finer and finer veins proceed until the whole green surface is divided up, like the parenchyma of many leaves, into a great number of small irregular meshes. This is well shown in our figure, representing the common Walking Leaf (*Phyllium siccifolium*), which seems to be widely distributed in Eastern regions. It owes its name of *siccifolium* (dry leaf) to the change of colour which it undergoes after death—a change which gave rise to the fanciful notion that the creature changed its colour simultaneously with the leaves surrounding it, an addition to the marvel of which there was certainly no need. In Java, as Mr. Wallace tells us, these insects "are often kept on a branch of the guava-tree; and it is a common thing for a stranger, when asked to look at this curious insect, to inquire where it is, and on being told that it is close under his eyes, to maintain that there is no insect at all, but only a branch with green leaves."

There are some other insects belonging to the same order as the Walking Sticks and Walking Leaves, but to that jumping division of the order which includes the creatures well known as locusts, grasshoppers, and crickets, which also merit the title of Leaf-insects. These animals form part of the family Locustidæ, of which the best-known English species is the Great Green Grasshopper (*Locusta viridissima*), an insect more than an inch long, which occurs among herbage and shrubs, situations in which its long and somewhat leaf-like fore wings may serve, to a certain extent, the purpose of concealment. In this insect, as indeed throughout the family, the wings are so arranged during repose that the hind wings are entirely concealed by the fore pair, which rise over the back of the insect like a more or less high-pitched roof. In most cases these fore wings exhibit a veining very much resembling that of a leaf; but in a considerable number of species—especially belonging to the tropical parts of the world—they become nearly as perfect representations of leaves as even those of the Leaf Insects *par excellence*. In evidence of this, we may take the names given by entomologists to many of the species, in which they are compared to the leaves of the laurel, lemon, citron, orange, camellia, and a number of other plants and trees; and the figures which we here give of a fine species from New Guinea, named *Phyllophora armata* ("the Well-armed Leaf-bearer")—the specific name being in allusion to the strong spines with which the edges of the large prothorax are armed—will serve to show how close the resemblance is. In some cases also the fore wings, instead of being as usual of a green tint, are more or less variegated with brown, thus again reproducing the characters of dead and withered leaves.

It must be remembered in all these cases that, in estimating the protective action of such resemblances, we must consider the insect not as stuck on a pin and arranged in a collector's cabinet, nor even as under observation alive in a show-case, but as placed in the midst of its natural surroundings, free to choose its own position on the plants or trees which it habitually frequents, and under the natural conditions of light and shade to which it will thus be subjected. Even in show-cases, when furnished with suitable plants, these Stick and Leaf Insects escape observation in a most marvellous manner, as may have been experienced by many of our readers in the case of the specimens which have been from time to time exhibited in the Insect-house at the Zoological Gardens. Some have neither noticed nor seen anything at all; but those who have looked carefully for these remarkable creatures must have experienced more or less difficulty in finding them, even though they knew well that they were there, and sought for them in a contracted space. But in their native haunts, according to the testimony of all observers, their withdrawal from sight, so long as they remain quiet, is most complete; and there can be no doubt that in these cases the mimicry of surrounding objects furnishes a most effectual protection even from the sharp eyes of their natural enemies.



WALKING LEAF (*Phyllium siccifolium*), FEMALE. (*Natural Size.*)

Phyllophora armata, A LEAF-LIKE LOCUST FROM NEW GUINEA (MALE AND FEMALE).

REMARKABLE FALSE ACCUSATIONS.

JACQUES DU MOULIN.

JACQUES DU MOULIN was a French gentleman who sought refuge in this country when Charles II. occupied the throne. He was taken into custody on a charge of passing and coining bad money, and the evidence against him was on his trial so conclusive that he was found guilty and condemned to die. It was shown that he had the appliances for coining locked up in a cabinet, of which he kept the key, and that he allowed no one but himself to open it. It was proved that he paid his tradespeople in bad money; and some came forward who swore that they had paid accounts to him in good money, which he asserted was bad, and for which he had substituted, and strove to force them to receive back, bad money. A woman named Williams, widow of a coiner of false money, being on her death-bed, sent for the wife of Du Moulin, and told her that one of a band of coiners with whom her late husband had been connected had been in her husband's service, and that he, and not her husband, was the guilty party. These men were arrested, and convicted also. They denied that Du Moulin was their accomplice, but the jury could see nothing in the facts proved that did not strengthen rather than weaken the case against the Frenchman. The servant whom the woman had denounced was pronounced innocent and discharged. A further search was, however, made on the premises, in deference to certain expressions of public opinion, which ended in the confession of the servant. In a secret drawer of his chest was found an impression made in wax from the wards of a key, and with it a key (on a bunch with others) which fitted the wax mould, which key also opened the cabinet, in which he had placed the coining apparatus to divert suspicion from himself, and from which he had taken good money to place the bad in its stead. If the criminal had not preserved the wax mould, the innocent would doubtless have suffered for the guilty.

JONATHAN BRADFORD.

IN the year 1736 Jonathan Bradford kept an inn on the London Road in Oxfordshire, and was held to be a very respectable man of excellent character. One evening a traveller named Hayes put up at his house and joined two other visitors at supper, to whom he imprudently mentioned the fact of his having with him a large sum of money. The two strangers slept in a room adjoining that occupied by Mr. Hayes, and one in the night, hearing deep groans come from the next room, awoke his friend. They crept out into the passage, found the door of Mr. Hayes' room open, and, by the dim light of the candle, saw a man armed with a knife and carrying a dark lantern, standing by the bed on which, weltering in his blood, lay Mr. Hayes. He was seized, disarmed, and recognised as the landlord, Jonathan Bradford! Persisting in asserting his innocence, he was committed, tried, pronounced guilty (the jury not even retiring from their box), and executed.

Eighteen months after, the real criminal was discovered in the person of Mr. Hayes' footman, who on his deathbed pronounced Bradford innocent. The landlord had, however, confessed that he had gone to the traveller's bedside to do the deed for which he suffered, but had found it already done. In his horror he dropped the knife on the bleeding body, and in recovering it stained both his weapon and his hand.

WILLIAM SHAW.

WILLIAM SHAW, an upholsterer, lived in Edinburgh in 1721. He had a daughter named Catherine, and she had a sweetheart named John Lawson, a jeweller, a profligate, whom her father had commanded her to avoid. She, however, continued to meet her lover clandestinely, and was consequently confined to the house. Mr. Shaw then brought forward another suitor for her hand, a young man named Robertson, commanding her to accept him. She obstinately refused to do so, declaring she would rather die, and a violent quarrel ensued, in which she loudly reproached him as barbarous and cruel, the word death being frequently repeated. James Morrison, a watch-case maker, who occupied the adjoining room, overheard the disturbance, and heard the upholsterer leave the room and lock the door after him. For a time he heard nothing more, but was presently alarmed by the sound of groaning. He aroused others who lived in the house, who listened at the door and heard the groans also, and heard, moreover, the voice of Catherine Shaw say, faintly, "Cruel father, thou art the cause of my death!" They knocked for admission, and, receiving no reply, sent for a constable, who broke open the door and found the wretched girl speechless, bleeding, and dying, with the knife which had inflicted the fatal wound beside her. The upholsterer returned while they were there, and it was at once seen that his shirt was bloody. He was arrested, tried, found guilty, and a few weeks after hanged in chains on Leith Walk.

In August, 1722, a man who had taken the apartment Shaw occupied chanced to find in a cavity on one side of the chimney a folded paper. It was a letter in which Catherine addressed her father, and announced her intention of committing suicide. The writing was recognised, and the innocence of William Shaw admitted. The crime discovered in this case was suicide, not murder—the homicide that of the law, not of William Shaw.

THE TREASURE-FINDER OF MARSEILLES.

In September, 1726, a young peasant of Pertuys, named Honoré Mirabel, appeared before the judicial authorities of Marseilles, demanding justice against a storekeeper in that city, named Auguier, who had refused to give up a large sum of money entrusted to his care, for which he held a receipt. The story he told to account for his possession of so large a sum was, that going to a well to drink, he heard a strange unnatural voice, which told him that a treasure was concealed in a spot upon which a stone was thrown by a hand unseen. The voice bade him dig it up, and with some portion of it pay for masses for a dead man's soul. He told this story to a neighbour's farm-servant and to his mistress, Magdeleine Caillot, and they with him early on the following morning dug on the spot indicated, and there found the money, more than a thousand large gold pieces of Portuguese coinage! He took these—he said—to Auguier, who told him the gold would be confiscated if the secret of how he got it oozed out, lent him money to spend, and took charge of the treasure. Not long after an attempt was made upon his, Mirabel's, life by an assassin in a lonely spot, and, believing that it was instigated by Auguier, he applied for the return of his money.

The storekeeper denied all knowledge of the money, and officers were sent to search for it. They returned without finding it, but stated that they had discovered just such a willow basket as Mirabel said Auguier had put the money into, and the gold-coloured ribbon with which the peasant said he had tied it up. Auguier was arrested on this evidence! He stated that he had seen Mirabel twice—once in his own house and once at a certain inn, that he had lent him two crowns, and that he was told by him about the treasure, but had never seen it.

As witnesses on the peasant's side appeared Magdeleine Caillot. She swore to the finding of the treasure, the gold-coloured ribbon, and that Mirabel had shown her a cut through his vest and shirt made, he said, by a tall powerful man who had tried to murder him. A third witness, Gaspard Deleuil, deposed that on the 6th of September he saw Mirabel deliver a packet to a man whom he was told was Auguier, and that the man gave in return a piece of paper, which he was also told was a receipt for the treasure Mirabel had been lucky enough to find. He swore, moreover, that he had himself reproached the storekeeper for his dishonesty, and that when he did so he looked frightened, grew pale as death, and implored him not to speak so loud.

Auguier, persisting in his assertions of innocence, was condemned to the torture, to avoid which the wretched storekeeper appealed to the local parliament of a neighbouring town, that of Aix, where in consequence the case was again heard, counsel appearing on either side. Here for the first time the farm-labourer who had assisted in digging up the treasure, a man named Bernard, was brought forward. He deposed that he was taken by Mirabel to dig for a treasure, which he said a ghost had pointed out twice, and on each occasion they found nothing! He declared also that Mirabel showed him a written paper which he said had cost him a crown, and when the supposed receipt, which Auguier was asserted to have written *in a disguised hand*, was placed before him, he recognised it as the paper he then saw!

After his evidence, the woman Magdeleine was recalled, and, being cross-examined severely, at last confessed that she had never seen any such treasure as Mirabel spoke of—that she had lied at his request. Evidence was also forthcoming to show that the receipt was a forged one, and that on the day it was said to have been given by Auguier he was eight leagues away from the spot mentioned.

Being threatened with torture, Mirabel confessed and was condemned to the galleys for life. He denounced, as his chief accomplice, a man named Barthelmy, who was a personal enemy of the storekeeper, and who shared the fate of Mirabel. The false witness Deleuil was punished by being pilloried in the public streets, suspended by the arm-pits. The woman Caillot was compelled to pay a fine, and was then sentenced for life to the galleys.

THE SUN IN TOTAL ECLIPSE.

Total eclipses of the sun afford phenomena of the most striking character. Apart from this, they open up a number of important facts for investigation, and it is not to be wondered at, therefore, that they command so much attention from the scientific world. It is unfortunate that they are only visible from small tracts of the earth's surface, and thus are seldom witnessed except by those enthusiastic *savants* who accompany one of the expeditions which are usually despatched for the purpose of securing important observations. In England not a single total solar eclipse has occurred since 1724, and the next will not take place until the summer of 1927—an interval of 203 years—so that the extreme rarity of these phenomena, as observed from this country, is at once evident. This is to be regretted in many respects. Had we occasional opportunities of witnessing a total eclipse of the sun without journeying to foreign lands, it would afford considerable interest to the British public, who could not fail to be struck with the imposing spectacle; while our astronomers might pursue their critical investigation with all the comforts and facilities afforded by such favourable circumstances.

THE ECLIPSE OF JULY 29, 1878, AS SEEN IN COLORADO, U.S.

One of the chief points of wonder connected with these eclipses is the supernatural darkness which creeps over the face of nature, and makes the observer involuntarily shudder as he becomes enveloped in dark flying bands of shadow, which are unique, so far as his experience is concerned. The sky wears a remarkable appearance, and at the moment of totality, bright flames and prominences are seen shooting from the edges of the eclipsed sun. These vary in a singular manner, and are truly marvellous in their aspect, until, in a few minutes, when the total phase has passed, a narrow arc of light bursts forth, and the shadows rapidly begin to retreat. The observer cannot but feel relieved at the reappearance of the sun, and the depression caused by the unnatural aspect of the sky leaves him as the surrounding landscape is bathed in a flood of the returning sunlight, and nature, animate and inanimate, reassumes her wonted appearance.

The last eclipse, with the exception of that in April, 1883, and one which appears to have been very effectively observed, occurred on May 17, 1882. An English expedition was sent to Egypt to obtain observations; and amongst the observers who accompanied it were several who are well known as successful workers in the department of solar physics. The duration of totality in this instance was only seventy-two seconds, so that we can readily understand the difficulty of an investigation limited to so short an interval, and the anxious desire of the observers to utilise every moment to the utmost possible capacity!

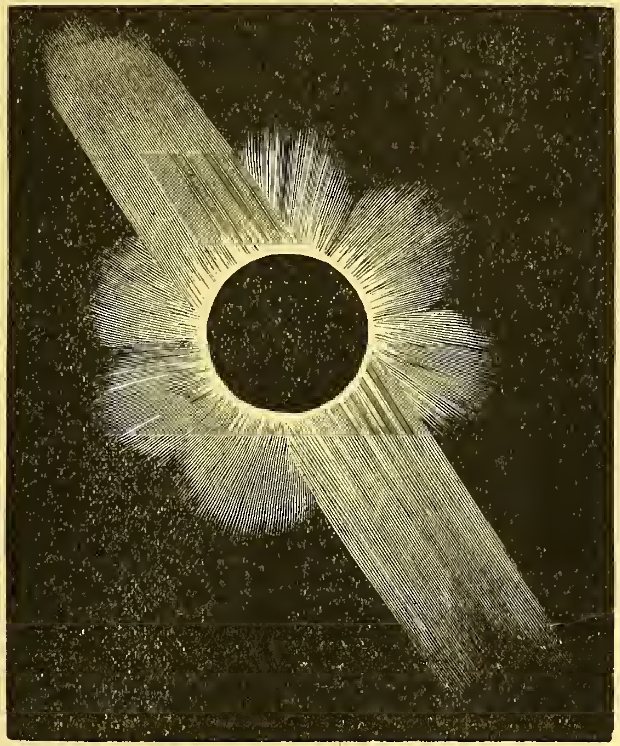


Fig. 1.—THE CORONA ON JULY 29, 1878.
As seen at Central City, Colorado.

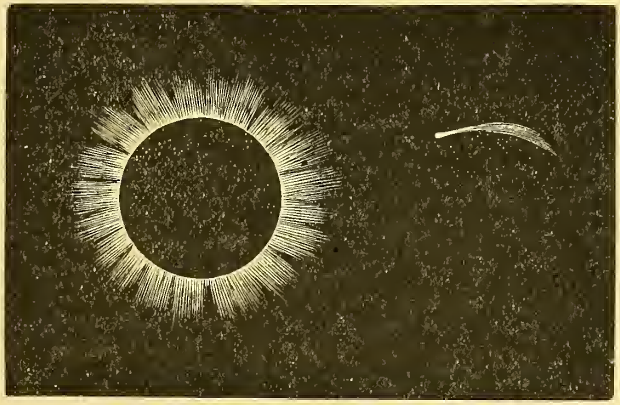


Fig. 2.—TOTAL ECLIPSE OF MAY 17, 1882.

The expedition left Gravesend for Egypt on April 19, and reached the station selected in perfect safety. It was not, however, without some misgivings that the eventful day was awaited, for though the weather offered a very fair prospect of success, the country was liable to be swept by oppressive south-east winds, carrying with them such immense clouds of dust as to effectually obliterate the sun. These fears were not realised, however, for the morning proved very clear; indeed, there was not a cloud to be seen in the sky, and the temperature was cooler than usual. The storm of dust which had been anticipated as a possible serious hindrance, did not put in an appearance, and thus the astronomers were free to pursue their labours amid every favouring condition. One of the most noteworthy features of the phenomenon was that a fine comet was visible close to the sun. It was plainly visible to the naked eye at the time of totality, and it is very distinctly shown on the photographs taken of the eclipsed sun and its coronal appendages, one of which is reproduced in Fig. 2.

Reference has already been made to what is called the corona (see page 194), and the great importance of its careful study by means of the spectroscope. A prominent aim of the expedition was to get more observations as to the form and probable nature of the corona by means of spectroscopic apparatus and photography. This appears to have been most effectively achieved, and some of the chief results were detailed before the Royal Society on June 15, 1882. This is all the more gratifying when we consider how rare the opportunities are of studying the corona, which for many years was rather supposed to be an appearance originated from the moon, and due in some way to the action of a lunar atmosphere. But the researches of recent years have unequivocally demonstrated the solar nature of the corona, and prove it to be a sort of outer luminous atmosphere of the sun, probably of variable form, and shining partly by inherent light, and partly by light received from the sun. The brilliant bands of light radiating from the eclipsed sun sufficiently indicate that its denser portions are arranged in streams, and the more diffused parts of this solar appendage are probably to be explained by a more evenly scattered congregation of atoms in the vicinity of the sun.

The radial forms of the corona are very different in successive eclipses. Of the eclipse of May 17, 1882, three photographs were obtained by Mr. Lockyer's party, and these proved that the corona on this occasion again assumed the form which it had in 1871, being but slightly extended away from the sun's equator, with no special structure at the poles, while during the total eclipses of 1867 and 1878 the radiations showed a great elongation away from the solar equator, and the poles showed some brilliant radiations. An important fact is suggested from this, viz., that the coronal variations coincide with the sun-spot cycle; for the years 1871 and 1882 are those of maximum solar disturbance, whereas in 1867 and 1878 the sun's disc was very quiescent.

One of the French observers of the eclipse of 1882 saw, several seconds before the end of the eclipse, the moon's limb projected on the bright background of the corona, three minutes of arc beyond the sun's disc. This affords the clearest confirmation, if any were needed, that the corona is something existing in the immediate region of the sun, and, in fact, purely a solar appendage.

A very interesting fact in connection with the visibility of the corona is that Dr. Huggins has lately discovered a method of photographing its spectrum without awaiting another eclipse. By a special arrangement of the spectroscope, an excellent series of photographs of the rifts and streamers near the sun's limb were obtained between June and September, 1882, and the opinion of experts is that these are genuine views of the corona. If this is accepted, and the new method found practically efficient to reveal the details of its structure from day to day, the discovery cannot but be regarded as a very important one in allowing astronomers to obtain photographic records of its diurnal variations. In any case, the investigation of this wonderful solar appendage, which is admittedly the most striking, and often the most startling, feature of a total eclipse, is of extreme interest and value.

THE GREAT LAKES OF CANADA.

As the traveller on leaving the Atlantic enters the River St. Lawrence, he observes rising from each bank two woody ridges of land. These ridges forking westward in irregular lines, and with an increasing elevation above sea-level, enclose the most diversified territory on the face of the globe. This territory excels in the fertility of its unnumbered acres of cultivable soil ; it excels in the richness of its mineral stores ; it excels, moreover, in the picturesque beauty and grandeur of its scenery ; and it presents a water-system that in extent and magnificence stands without a rival in the world.

This great water-system, beginning its giant career in the unpretentious streams that gush into Lake Superior, bears their accumulated waters to the south-eastern extremity of that lake, and thrusts them down the narrow Rapids of St. Mary into the basin of Lake Huron. This lake receiving likewise the waters of the rivers that flow into Lake Michigan, and also fed by numerous streams of its own, drives this increasing load southwards into the River and Lake of St. Clair, whence it issues by the River Detroit into Lake Erie. Here, however, the flood is not allowed to stay ; so, wheeling towards the north-east, it soon passes in a broad and silvery expanse between the low banks of the River Niagara. At this stage the mass moves slowly on. By degrees, however, its speed quickens, as if in preparation for the leap that must soon be taken. At length it has reached the roar of the cataract ; and, first becoming restless, then uncontrollable, it tears through the Rapids, and bounds over the precipitous crag of Niagara. The troubled stream next reaches Lake Ontario, where it regains composure, but not rest ; for this lake, conveying its surplus waters to its north-eastern shore, pours them into the channel of the River St. Lawrence, which thus rolls into the Atlantic Ocean 4,512,000,000 tons of water every day !

Having given this general, and necessarily brief view of the water-system to which the great lakes of Canada belong, we may proceed to point out the more striking features connected with the lakes themselves. Returning, therefore, up the St. Lawrence, we receive the first intimation of our nearness to Lake Ontario in the sudden expansion of the river into a large basin, which, from the countless multitude of its islands, is named the "Lake of the Thousand Isles." The character of these islands is as varied as their number is great. Some are fertile, and clothed with the verdure of a luxuriant vegetation ; others are barren and bare. Some, again, are low, while others are lofty. They also exhibit the greatest variety in size. Indeed, as one writer says, "Nature seems here to have thrown sportively from her hand a profusion of masses of the material world, that she might perceive what combinations of scenery would be produced when they assumed their respective positions on the bosom of the waters." To steer a boat through this labyrinth requires a familiarity with certain channels, for the view ahead is quite shut off by these myriads of islands. When at length the curtain is withdrawn, there bursts upon the astonished eye a vast tract of rippling water, whose receding shores, displaying an endless diversity in form and loveliness, sweep from view beneath the horizon. This magnificent scene, in earlier days unsealing the lips of the taciturn Indian, made him exclaim, "*Ontario!*"—which means "The Beautiful."

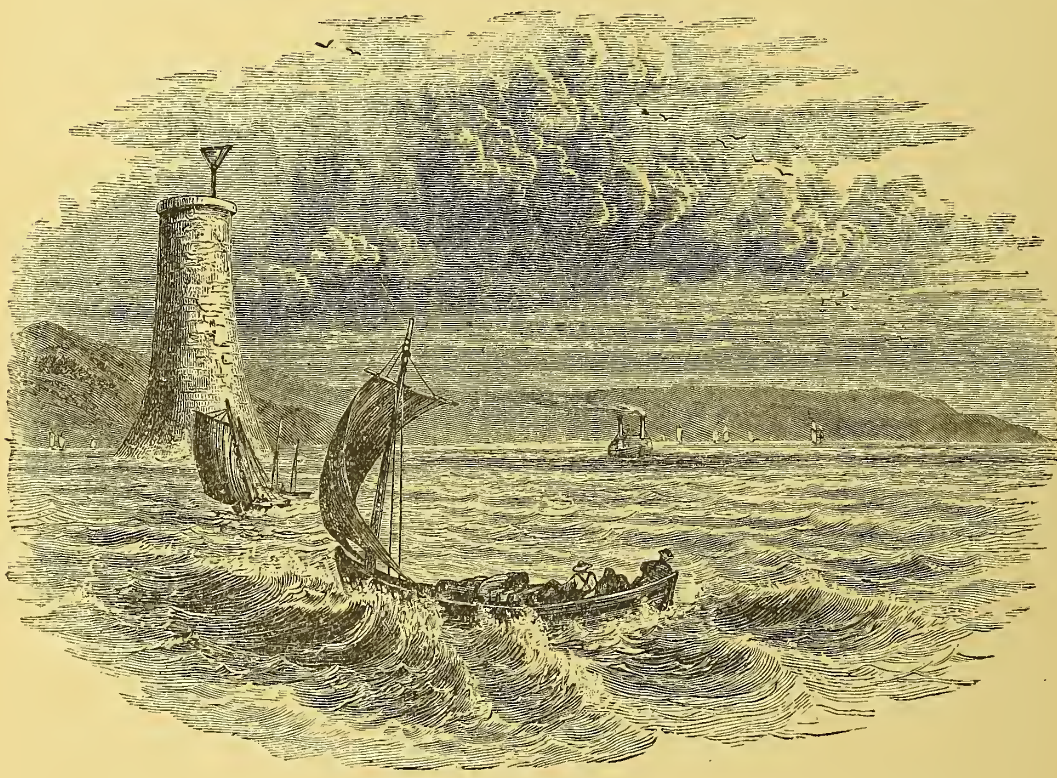
Lake Ontario is, in point of size, the least of the four great Canadian lakes. Stretching in a south-westerly direction for a distance of 180 miles, it separates the Canadian and United States frontiers. Its breadth is fifty miles, and it lies at an elevation of 234 feet above sea-level. On account of its great depth, it is not so easily lashed into violence by storms as its more shallow neighbour, Lake Erie. It is therefore well adapted for every kind of navigation, and for pleasure excursions is one of the most pleasing in the whole range of Canadian lakes. Its shores, indented by a succession of fine bays, afford landing-places and harbours, requiring little labour to render them fit to receive ships of the largest construction. Its surface, partly by reason of the continual flow of its waters—half a mile an hour—is never frozen over, and steamers make occasional trips during the finer days of winter from Toronto to Niagara. It is adorned with several islands of considerable magnitude—especially at its north-eastern extremity, where Nature seems to have spared no effort to produce the loveliest pictures. The clear blue surface of the lake, the deep tints of the luxuriant foliage, the flapping wings of some disturbed bird, the distant sound of the woodman's axe, and the curling smoke ascending from a cabin concealed amid the trees, fill the eye and the ear with sights and sounds whose effect surpasses the sublimest music.

Coming now to Lake Erie, we are 333 feet above Lake Ontario, and consequently 567 feet above sea-level. This lake, stretching in the same south-westerly direction as Ontario, is 220 miles in length, and about the same breadth as that lake; it thus presents us with a much larger area. Being, however, very shallow—its mean depth does not exceed 120 feet—it is easily agitated by storms that render its navigation exceptionally perilous. During these storms it is frequently enveloped in a thick mist, that makes it impossible to see to the distance of ten yards from the shore. Caught in such a storm, a vessel depends very much for its safety upon chance, for it is liable to be driven upon reefs, which are very numerous, or dashed against some projecting piece of land. Owing also to its shallowness, it becomes frozen over in winter, and thus offers another impediment to the shipping. It is deficient, too, in good natural harbours and anchorage. Not nearly so suitable for navigation purposes as Ontario, it nevertheless bears more than twice the number of vessels that are to be found on that lake. In fact, it has become the main centre of inland navigation; for being connected by means of great canals with the Hudson and Ohio rivers, it can conduct vessels to the Atlantic, to the Mississippi, and the Gulf of Mexico. Consequently its trade is comparatively immense; and although it cannot compare with Ontario in the fascination of its scenery, still along its western shore there lies the region that, from the richness of its soil, is known as "The Garden of Canada."

The banks of Erie, consisting entirely of clay and sand, have by the action of the water been cut and excavated into the most fantastic and curious shapes. Bold and elevated in many places, they form deep ravines of the wildest description. A numerous group of beautiful islands rises near its south-western extremity. Spread round these islands for a space of twenty miles is a large quantity of water-lilies, which, viewed from a distance, present a more than usually inviting appearance. Closer examination, however, is said to reveal the disappointing and horrible presence of a numerous throng of serpents entwined round these lilies; hence these islands receive the name of Viper Islands. The largest island in the lake is Pelee, near the mouth of the Detroit; upon it is built a lighthouse, and it contains several farms. Close by is the entrance into this lake of the surplus waters of Huron.

This vast sheet of water, presenting a very irregular outline, covers a much wider area than Erie or Ontario. Situated thirty feet higher than Erie, Huron extends in a north-westerly direction for a distance of 250 miles, and is 220 miles broad. Its mean depth is 900 feet. From this great depth there rise 32,000 islands, varying in size from rocky reefs and bare-pointed islets to extensive tracts covered with the drapery of a luxuriant vegetation. The chief of these islands is the Great Manitoulin, which, stretching along the northern shore for a distance of seventy-five miles, struck the native Indian with superstitious awe, and made him assign it as the favourite abode of "The Great Spirit."

The banks of this lake are of an extremely diversified character. Occasionally low and sandy, they are oftener broken into heights of upwards of 100 feet, formed of clay, rolled stones, precipitous rocks, and woody steeps. The borders of the lake are sparsely settled, and upon the north Nature's wild reign may be said to be still unbroken. Its waters contain an abundance of fish, the most remarkable of which is a trout measuring from four to five feet in length, and weighing 70 lb.—some say as much as 200 lb. This fish, known as the Michilimakinac trout, is said to afford a most delicious food of extreme richness. Near the outlet of St. Mary, at the north-west, are two fortified frontier stations—one British, on St. Joseph Island; the other, on Drummond Island, belongs to the States. At this part of the lake Indians, laden with the skins of beavers, martins, foxes, and other animals, were wont to assemble in spring-time, to exchange their furs to the north-west traders for the manufactured products of civilisation. Provided with the smoked flesh of the bear, of the stag, of the buffalo, and of the elk, they would encamp here for several weeks, drinking the fire-water that they had received for their skins, and would indulge in the most frightful excesses and wanton debauchery. These orgies would continue until, their provisions exhausted, hunger compelled them to return to the forest to seek for food.

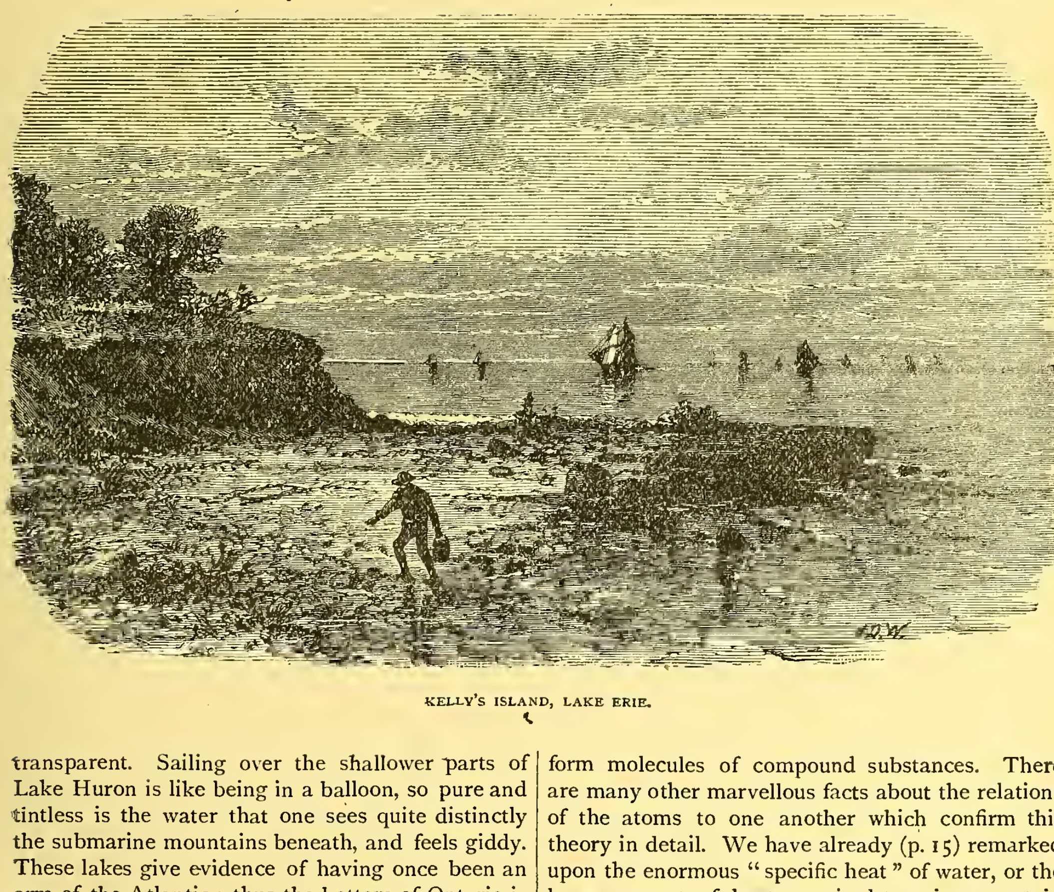


LAKE ONTARIO

From this lake many navigable streams ramify throughout the country, affording an extent of water-communication that destines it to play an important part in developing the vast resources of the Far West.

Coming now to the last of these inland seas, we find ourselves, at a height of 627 feet above the ocean, face to face with the largest body of fresh water in the world. Lake Superior, the queen of the whole group, covering an area of 32,000 square miles, is as large as Ireland, and more than double the size of any of her great sisters. Magnificent in its immensity, this lake is also magnificent in the wild grandeur of its scenery. The grotesque shapes assumed by its rocky shore through the action of its waters resemble in many places mediæval castles, temples, colonnades, and other high forms of architecture—the whole presenting a merciless front to the storm-driven barque. The most remarkable of these freaks is "The Grand Chapel," which, standing fifty feet above the lake upon two massive and symmetrical columns supporting a dome, exhibits all the regularity of skilled workmanship. Scenes of softer beauty, moreover, are not wanting; smiling islands rising from the deep bosom of the lake present a pleasing contrast to these frowning crags. The navigation of the lake is still in its infancy, and its primeval solitudes may almost be regarded as still undisturbed. Behind its rock-bound coast, however, are silver mines and deposits of copper, that make it, after California, the richest mineral district in North America. Upon its largest island —Isle Royale—and on its northern shores remains of very ancient copper mines and mining tools have been found, pointing to a former race well advanced in civilisation having at some remote period occupied this country.

Such, then, are the four great lakes of Canada, frequently called, by reason of their magnitude, the "Canadian Seas." They are computed to contain, with their tributaries, more than half the fresh water on the globe; they cover a space of 93,000 square miles, and drain 400,000 square miles of country. A striking difference is observable between their waters: Ontario is pure and blue, Erie pure and green, Huron and Superior clear and transparent. Sailing over the shallower parts of Lake Huron is like being in a balloon, so pure and tintless is the water that one sees quite distinctly the submarine mountains beneath, and feels giddy. These lakes give evidence of having once been an arm of the Atlantic; thus the bottom of Ontario is salt, and marine forms of life have been found in a fossilised state as far west as Superior. Moreover, the water appears to have been much higher than it is now, and is even supposed to be still receding. Should these vast basins ever become emptied of their floods, there will be revealed the most striking phenomenon that the world has yet seen. Imagine some remote inhabitant of these regions looking from the rocky banks of Huron into its empty bed, from the deep bottom 32,000 pinnacles ascending, and we shall have a faint idea of one of the possible wonders yet in store for the world!



KELLY'S ISLAND, LAKE ERIE.

ATOMS AND MOLECULES.

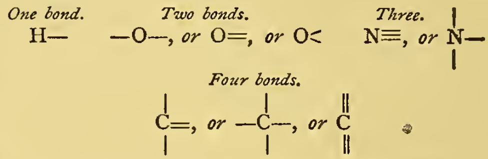
IN an article upon "Matter and its Particles," (p. 309) we have very briefly summarised the general grounds upon which the "Atomic Theory" of matter and its elements is now generally received by physicists and chemists. Both believe in definite ultimate particles of every element, called "atoms," of different comparative weights. These either remain alone, or combine with one or more atoms of the same sort to form "molecules" of the element; and with atoms of other elements to form molecules of compound substances. There are many other marvellous facts about the relations of the atoms to one another which confirm this theory in detail. We have already (p. 15) remarked upon the enormous "specific heat" of water, or the large amount of heat required to raise a certain amount of water one degree in temperature, as compared with other substances. Now the specific heat of every solid element has been measured, and the figures differ as much as 1 to 30, bismuth being ·0308, and lithium, ·9408. The atomic weights of the solid elements differ, on the other hand, also as much as 1 to 30. But when either of these numbers for any element* is multiplied by the other, we get

* Till very lately, carbon, silicon, and boron were believed to be exceptions; but the recent researches of Weber and Brodie have brought the differences within the small limits which must be allowed for errors in such delicate observations.

the same number always : or, in other words, the "capacity" for heat of the single atom of every element is the same.

Again, the physical properties of the elements seem to depend upon their atomic weights ; and this fact comes out in several remarkable ways. Arranging them all in the order of their atomic weights (which, it will be remembered, represent simply the *proportionate* weights of the atoms, starting from the hydrogen atom as 1), we find the properties gradually modified as the weights increase. In the next place, the gradual increase of atomic weight was upon the whole pretty regular, but still left some years ago several marked gaps. The most conspicuous of these gaps have been filled up by freshly-discovered elements within late years; and before the metal gallium was discovered its density was foreseen. Yet again, and strangest of all, the Russian chemist Mendelejeff has shown that, after a certain number of elements in the order of their atomic weights have occurred in succession, and their various physical properties been remarked, there is a strange *repetition* of another series with very similar properties ; and this is repeated again and again. In this way the elements seem grouped into families ; sodium and potassium, for instance, being next neighbours in one similar "family," and having very similar properties, though their atomic weights are no nearer than 23 and 39·1. The members of one "family" being thus considerably apart in atomic weight, strange to say their *own* atomic weights are usually found to show unmistakable signs of a definite arithmetical progression. Perhaps the most marvellous fact of this class is the relation of atomic weight to wave-length. It has been shown already, in articles upon "Spectrum Analysis," that the "lines" of metals in the gaseous state, represent fixed periodic vibrations of the atoms. We know very well also, by daily experience, that heavy bodies vibrate more slowly than lighter ones, just as we lower the note by "loading" a tuning-fork. Now, taking the metals of a "family" group, such as has been described, M. de Boisbaudran has very lately shown that as the atomic weight increases, as a rule, the period of atomic vibration, and consequent wave-length, increases, or the "lines" of the metal approach nearer the red end of the spectrum.

The facts are equally remarkable concerning the chemical combination of atoms into either elementary or compound molecules. It is found that every atom has a specific number of bonds, or attaching-points, by which it links itself on to other atoms. Such capacity of a given element to attach a certain definite number of bonds of other atoms to itself, is called "atomicity," or "quantivalence," or valency. It is important to understand this, which is the very foundation of all modern chemistry ; so, representing atoms of hydrogen, which has one such bond, and oxygen, which has (usually) two, and nitrogen, which has (usually) three, and carbon, which has four, by their proper symbols, H, O, N, C, we may represent the bonds by little strokes projecting from the letters :—

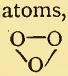


It will be understood from these diagrams that *how* the strokes are attached to the symbols does not matter ; all they mean is that their free ends represent points, or attractive forces, by which other free bonds of other atoms are at liberty to attach themselves. Also, two atoms can be linked together by either one, or more, of their bonds ; which are then "closed," and so no further at liberty for the attachment of other atoms.* The affinity of the latter may indeed be so superior as to break up the combination, and form another ; but in that case also all the bonds concerned in the most complex chemical combination have to be "closed." This being understood, we can grasp some marvellously interesting details of molecular structure.

We have seen that the hydrogen molecule consists of two atoms ; molecules of oxygen and nitrogen are also diatomic. The hydrogen molecule is therefore represented by H—H, and no other combination is possible. Similarly, the oxygen molecule is represented by O=O, the two atoms being united by both of their bonds, which are thus closed. Hence we understand at once why the chemical affinity of these elements is so much less in their free state, when their atoms are united into molecules, than while the *separate atoms* are being liberated during chemical reactions. In

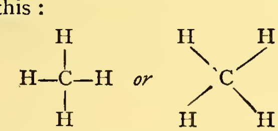
* The atomicity of the elements is not *invariable.* Nitrogen is generally tri-valent, but in some combinations unites by five bonds. Chlorine is generally uni-valent, like hydrogen, but it is occasionally as high as septi-valent. Other elements are bi-valent, quadri-valent, and sexi-valent ; and carbon, almost always quadri-valent, in its monoxide CO is bi-valent. The bonds almost always increase or diminish by two at a time, so that elements retain in all the degrees an odd or even number of bonds ; hence it has been thought that the higher atomicity is the true one, but that many atoms have a strong tendency to close two bonds between themselves, so that carbon monoxide would be represented thus <C=O. The rule is not, however, quite universal, nitrogen appearing bi-valent in N=O. It has further been found that, taking the elements comprising such a "family group" as has been already described, the atomicities gradually multiply with increase in the atomic weight. This is a strange fact, which again brings the physical properties of atoms into relation with their atomic weight : thus oxygen almost certainly possesses six and not only two bonds, though only two are generally active ; and six corresponds with its atomic weight. But as a general rule, the facts may be taken as stated in the text, and sooner or later the explanation of the occasional changes in atomicity will probably be discovered.

the birth stage or "nascent" state, such unattached atoms attack other atoms with all the strength of their free bonds, and so oxygen gas "rusts" metals far less rapidly than water does. Further, we can see in a moment that the double bonds of oxygen atoms might be "closed" by a combination into one molecule of *three* atoms, in this way—

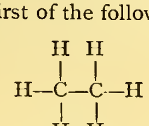


What is known as "Ozone" is just this, and nothing else; it is a gas composed of three oxygen atoms in a molecule, a sort of hyper-oxidised oxygen. It will be observed that each atom is only tied to its neighbour by *one* bond in this case; hence the molecule is less stable, and easily decomposed, when two volumes of ozone expand at once into three volumes of oxygen, proving what has already been said about equal numbers of *molecules* (not atoms) in equal volumes (p. 310). The less strength with which the atoms are held together, also shows us why ozone is so very energetic as an oxidising agent. Nitrogen molecules, on the other hand, are held together by a triple bond, thus :—N≡N ; and the strength of this triple attachment shows us why it is such an *inert* element : its two atoms are not easily forced apart to form other combinations.

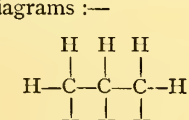
Let us now consider carbon with its four bonds. How would it combine with hydrogen? Obviously, no other way for a single atom of carbon is possible than this :



The carbon atom must have four hydrogen atoms to close its bonds, since the latter have only one bond apiece to do it with. This is the composition of methane, or marsh-gas. But if two carbon atoms are to combine with hydrogen into one molecule, they must do so differently. If they combined with eight (*i.e.*, double the above), it would simply make two molecules, since each would be complete and its bonds closed : it would be still marsh-gas. But they may combine as in the first of the following diagrams :—



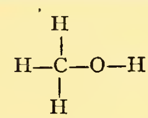
ETHANE.



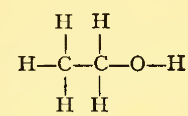
PROPANE.

where the two small carbon atoms bind each other, by one bond of each, so leaving bonds for six hydrogen atoms to attach themselves—this is a molecule of ethane. Similarly, three carbon atoms can at the most (*i.e.*, if *combined*) only attach eight atoms of hydrogen, which makes a molecule of propane.

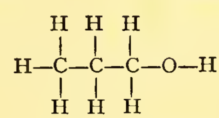
Now it will be seen that, while it by no means follows that the strokes in the above diagrams represent actual positions in space, the idea does necessitate an actual *definite atomic structure* to every molecule. We can establish this a vast deal further. For instance, let us take away from the molecules of methane, ethane, and propane described above, *one* of their respective atoms of hydrogen, let us say that on the right hand of each diagram. This gives us one unattached bond—a combination which cannot therefore exist by itself, but which can be linked on by that bond to either any other uni-valent element, or to any other atomic *compound* having one bond similarly to spare. Such combinations with spare bonds are called *compound* "radicles," in this case methyl, ethyl, and propyl.* Let us link on to each the other radicle —O—H (called hydroxyl). Another hydrogen atom would close this, making H—O—H (water); but as it is, there is one bond unattached, which is what we want; and by this bond we substitute —O—H for the —H we have taken away. These are the results :—



METHYLIC ALCOHOL.
(Wood Spirit.)

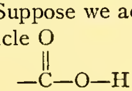


ETHYLIC ALCOHOL.
(Common Alcohol.)

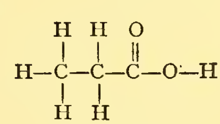


PROPYLIC ALCOHOL.

There are many more alcohols formed in the same way. We may, of course, add more complex groups than —O—H, provided only there be the one spare bond, and no more. Suppose we add to the ethylic radicle above, the radicle



the result is



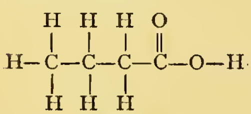
ACETIC ACID.

And so we may go on. The whole system of

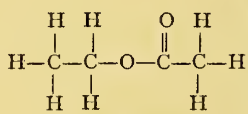
* It has already been seen that *pairs* of bonds appear to a certain extent capable of being self-closed ; but it will be easily understood that radicles with one or any odd number of free bonds cannot exist in a free state. For instance, taking one atom of hydrogen from methane or marsh-gas (CH_4) we get as above the radicle methyl ($-CH_3$). This does not exist, but *doubles* itself into the molecule C_2H_6, variously called ethane as above, di-methyl, or hydride of ethyl. Taking away two atoms of hydrogen from methane we get methene ($=CH_2$), which is of course bi-valent; and taking away three we get the tri-valent radicle ≡CH, which again cannot exist, but which, when its three spare bonds are satisfied with three atoms of chlorine, becomes *chloroform*.

chemical reactions depends upon the *substitution* for any atom or group of atoms taken away, of another atom or "radicle" group, having the same number of spare bonds.

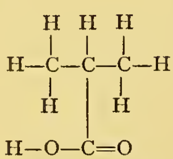
A little consideration shows us that if this theory be true, while simple groups can only be put together in one way, more complex combinations admit of various groupings. For instance, the next chemical combination $C_4 H_8 O_2$ of the same order as the last, can be grouped in either of three ways so as to satisfy all the bonds ; accordingly, three compounds have been actually formed as underneath, possessing quite different properties, though composed of the same elements in the very same proportions :



BUTYRIC ACID.



ACETIC ETHER.



ISOBUTYRIC ACID.

Some of the more complex molecules of this class comprise over a hundred atoms, and the possible combinations are proportionately numerous. Many of these "isomeric" compounds, as they are called, are already known ; and some one or other not previously known is being discovered almost every day, the discovery being nearly always based upon the supposed atomic grouping, which enables the chemist to prepare reactions calculated to afford the substitution of the desired radicle or sub-group of atoms by the necessary bonds.

An interesting illustration of the structure of molecules, here attempted to be described, and which will put these laws and methods of chemical combination in a striking light, may be found in the peculiar hydro-carbon compound called Nitro-Glycerine, which we accordingly reserve for a separate article.

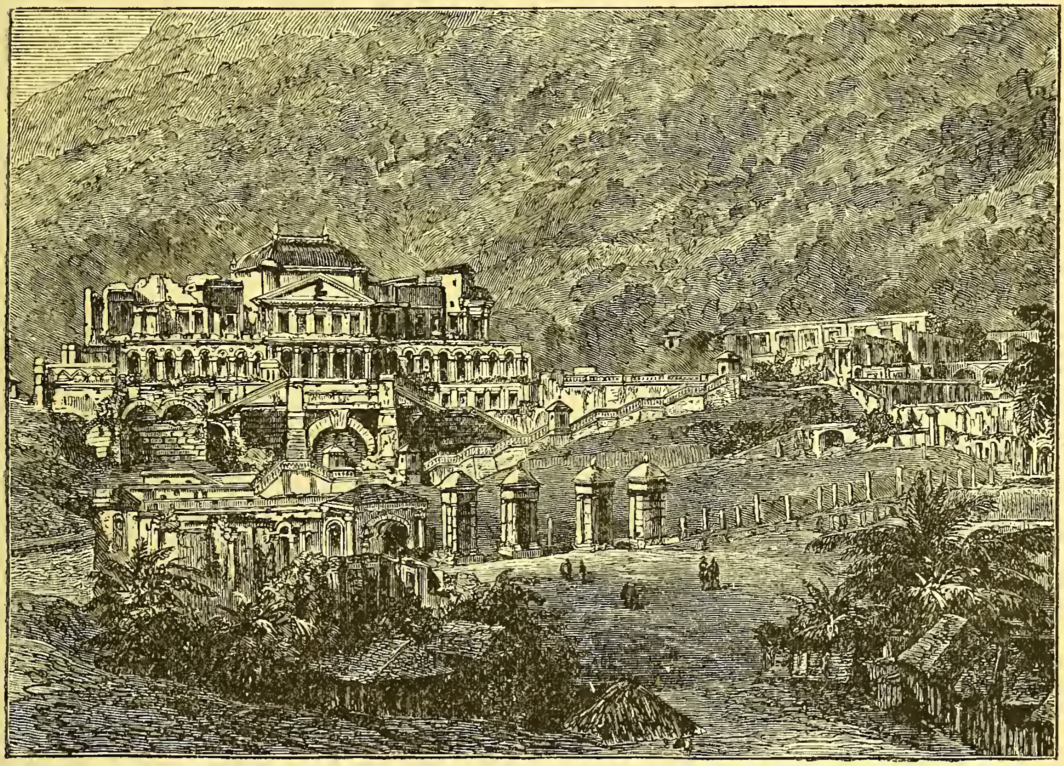
KING CHRISTOPHE AND HIS PALACE.

ON the north shore of the Republic of Hayti is situated a town which, in the time of its greatest prosperity, was known as the "Paris of the West Indies." This was the original Guarico of the Spaniards, the Cape François of the French, Cape Henry after King Christophe, and the present Cape Haytien, or simply The Cape. To-day it lies mostly in ruins, and one may traverse the remains of what have been noble streets, and see on either hand arches, pillars, balconies, doorways of carved work, and notice in the interiors of court-yards, halls, and saloons, tropical vegetation growing luxuriantly, hiding with its kindly covering the desolation, begun by man, and completed by the commotions of nature.

During the troubles which befell the island after the declaration of independence, Christophe, originally an African slave, soon succeeded in making himself supreme over all competitors for the chief power, and on June 2nd, 1811, he and his wife were crowned at Cape François as King and Queen of Hayti. After the ceremony he gave a magnificent banquet, at which King Christophe proposed the health of his brother, the King of Great Britain. He next proceeded to create various ranks of nobility, and issued his royal edicts for the establishment of a royal guard, an order of knighthood, and an ecclesiastical hierarchy. The body-guard consisted of 250 infantry and a company of light horse. The new military order—the Order of St. Henry—was to consist of the king, the prince royal, sixteen grand crosses, and thirty-two commanders. The king had various residences in the beautiful plain of the Antibonite, in the north of the kingdom, such as the "Queen's Delight," the "King's Beautiful View," the "Conquest," the "Victory," and the "Glory." But at the village of Milot was his favourite dwelling-place, and the head-quarters of the kingdom.

At the distance of half a day's journey from Cape Haytien is the village of Milot, and here, on the slope of a hill, the king built his palace of Sans Souci. "Imagine," writes one of the few travellers who have been permitted by a weak and jealous government to visit the place, "imagine a long, narrow, lovely valley, clothed in verdure, shut in by high hills, and ending at one extremity in a gently-rising knoll, that blocks up the narrow ravine between two grand, high mountains, the precipitous faces of which seem the walls of a natural fortress, and you have an idea of the natural location of the place." The site was well chosen in every particular. There was a superb view of the valley below and the hills around. The original plan of the palace was primitive, but as the king's power increased it was being continually added to ; and thus, when finished, it was very irregular in its architecture. There was a basement, and then a second storey, and above this a belvidere, or look-out, whence magnificent views were obtained. On the right was the throne-room, and in the basement was situated the circular church used by Christophe and his family. Upon the left was the Caimito Terrace, so called from a large tree of that kind, which completely overshadowed it. There were large buildings for the officers and secretaries, and adjoining these were other solid buildings for the king's numerous carriages and state equipages. Behind the palace were large gardens, filled with tropical fruit, vegetables, and flowers, and water from the neighbouring hills ran through the grounds in cascades, imparting a delightful coolness to the scene. Ranged above the main palace were storehouses, arsenals, and barracks; and here, too, were found the royal printing-offices, the Mint, and other official buildings. "Ravines have been filled up," writes the king's agent in England at that time, "mountains levelled, public roads laid out. This superb royal palace, its sumptuous apartments, all with inlaid work, and lined throughout with the most beautiful and rarest tapestry: all these combine to embellish the retreat of a hero. I know it to be the intention of our king to have the rotunda of his palace paved, and lined with quadruples. Such a novel species of apartment will reflect precious drapery, and be without a parallel in the world."

The citadel was constructed originally by the French upon a peak of a chain of mountains called the "Bishop's Hat," at a height of several hundred yards above the sea. It was begun in 1804, and finished in 1820. The walls of the fortress were built upwards from the solid rock, and were from fifteen to twenty feet in thickness, all of the most solid masonry. So great was the height above the valley immediately beneath, that, standing upon the battlements, there were few who did not feel dizzy. From this spot many thousands of his unfortunate subjects were thrown by the king's orders; in fact, so numerous were the executions at this spot, that the place became popularly known as the "Grand Boucan." It is said that not less than 30,000 workmen perished during the construction of this citadel, through over-work and want of food. The view from the summit was unrivalled in the whole island. On the left could be seen the island of Tortuga, the favourite resort of the old buccaneers; in front the city of Cape Haytien, with its fine harbour and a wide expanse of ocean; on the right, in the direction of the Dominican frontier, were La Grange, Monte Christo, Fort Royal, Manzanilla Bay, and the surrounding hills.



THE PALACE OF KING CHRISTOPHE.

Here King Christophe ruled for fourteen years. Seated on a throne placed under the Caimito tree already mentioned, he held his court. The fair promise of his earlier years quickly vanished. His officers and people, it is said, dared not look him in the face, but knelt before him as slaves. With a wave of his hand he consigned to the dungeons or to death any who had displeased him. If he wanted a carriage or other article made, the artificer would be brought into his presence. "How long will it take you to make one like this?" would be the king's question. "Three months," the wretched man replied. "If it is not here before me in two weeks, finished completely, you will be thrown from the battlements," was all that Christophe said, and the doomed man would be led away.

At length his intolerable tyranny provoked a rebellion. The king's troops were defeated in the open country, and at last he was shut up in the citadel. He promised the most lavish rewards to his soldiers to remain faithful, but in vain. When he knew that he stood alone, he withdrew to his own chamber, and blew his brains out with a pistol. After his death the citadel and palace were plundered by the rebels, and many grew rich from the treasures they had seized; gold, silver, and other precious things. Most of the buildings are still standing, but since the great earthquake of 1842 they have not been inhabited to any great extent. As long, however, as a stone stands in these walls, so long there will exist on the earth a monument to one of the greatest monsters that have disgraced humanity.

ROSE TAMISER.

THE European reputation which Rose Tamiser achieved by her supposed power of working miracles, is amongst the most wonderful things on record. She was a poor girl, who had been educated gratuitously in a convent at Salon, Bouches-du-Rhone, where she became a nun, and announced herself as in the habit of receiving the visits of saints and angels. At last she left the convent, and returned to her native village, Saignon, where she began to preach, asserting that it was her divine mission to restore the Christian religion to its primitive state of purity. In proof of her divine inspiration, it was said she performed miracles. On one occasion when the villagers were starving for want of food, it was affirmed that she caused a single cabbage to suffice for their support during several successive weeks, it growing when every other kind of vegetable was killed by the prevalence of a wide-spread drought. She professed herself to be fed with consecrated wafers, with which she was regularly supplied by angels. She called down from heaven materials for mending the clothes of her curé, the Abbé Sabon. She was carried by angels from Saignon to St. Saturnin one fine evening in summer, and there her repute spread so rapidly and so far, that soon all Europe was talking of her and her miraculous doings. Figures of a cross, a heart, a chalice, a spear, and sometimes those of the Virgin and Child, appeared on her body as if drawn in blood, which sometimes exuded from them. On the 10th of November, 1850, Rose caused a picture of Christ taken from the cross to emit real blood. This miracle she performed in the little church of St. Saturnin, and thereby attracted so much attention, that the French Government sent a commission to inquire into her pretensions, and duly report thereon. This consisted of M. Grave, the sous-prefet of the department, M. Guillibert, juge d'instruction, M. Jacques, substitut du procureur de la republique, and others, civil and military. Even Monsignor, the Archbishop of Avignon, with the higher clergy of his diocese, came forward to bear witness to and verify the miraculous power of saintly Rose Tamiser. The occasion was one which attracted thousands to the little romantic village, and those who were assembled within the church, the great civil and ecclesiastical dignitaries, appeared in their state costumes and insignia. At the bidding of Rose, blood again oozed from the painted flesh, and at the command of his Grace the Archbishop, the picture was taken down from its place above the high altar, when lo! to the astonishment of the incredulous, who expected to see some kind of machinery, and to the glorification of believers, who had denied any trickery, the back of the canvas was found to be thickly covered with cobwebs, the home of a colony of ancient spiders! And still the blood continued to ooze from the canvas as fast as the Archbishop and the prefet could wipe it away from the feet, hands, and side of the painted figure! These handkerchiefs were at once in such demand that they were cut into shreds, and carried away to all parts of the country.

Thus everybody was satisfied, or professed to be so, and the mystery remained a mystery to all who were unwilling to accept it as a genuine miracle performed by an inspired woman. The same miracle was repeated frequently both in 1850 and in 1851, when M. Eugene Colignon, a chemist of Apt, announced, as the result of numerous experiments, that human blood disgorged by a leech, having lost its fibrin, might be made to penetrate a painting, and then come again to the surface in small drops or globules. This he successfully demonstrated before a large number of eminent scientific men and some public authorities. In consequence of this being done, Rose was arrested, and charged with imposture. Her trial took place at Carpentras, the chief town of the district; and the jury, on the ground that they were incompetent to decide a question so obscure and complicated, refused to deliver a verdict. The case was consequently transferred to the assizes at Nismes, where, in November, 1851, the supposed saint was pronounced guilty of *escroquerie et outrage à la morale publique et religieuse*, and sentenced to six months' imprisonment, and to pay the costs of her trial, with a fine of 500 francs.

THE ELECTRIC TELEGRAPH.

LONG before electric currents were discovered, men had adopted means of signalling news to distant places. Beacon-fires, which blazed on the hill-tops a warning of invasion, or other impending event, were the first telegraphs. These gave place to rude semaphores. Afterwards, this system was much improved, and the semaphore took much the same form as one of our modern railway signal-posts with its movable arms. Things were in this state when, in 1816, Mr. Ronalds (afterwards Sir Francis Ronalds) showed that an electric telegraph was possible, and endeavoured to persuade the Government of the importance of his system. The official reply to his appeal was as follows :—" Mr. Barrow presents his compliments to Mr. Ronalds, and acquaints him, with reference to his note of the third instant, that telegraphs of any kind are now wholly unnecessary, and that no other but the one now in use will be adopted. Admiralty Office, Aug. 5, 1816." The "one in use," here indicated, was the semaphore as above described, which, it may be mentioned, was quite useless during the night, or when fog prevented the signals being seen.

But even had Mr. Ronalds received a more encouraging reply, his system was, although ingenious, hardly practicable. In this system, the current from a Leyden jar caused the divergence of two pith balls hung together at the farther end of a communicating wire. In practice, each letter of the alphabet would require a separate wire, a complication which was common to nearly all the first suggested telegraph systems. In 1821, Ampère pointed out that a galvanometer placed in a circuit would afford means for the transmission of signals. A galvanometer (see Fig. 1) is simply a magnetised needle, balanced on a point, and surrounded by a coil of wire (one can be readily extemporised by winding a few layers of insulated copper wire across a common mariner's compass). If the instrument be so placed that the direction of the coil coincides with that of the needle (*i.e.*, north and south), the needle will be deflected to the east and west position directly a current is sent through the coil. If the direction of the current be reversed, the needle will move in the opposite direction. So that by rapidly changing the direction of the current, the needle will be alternately deflected to the right and left.

In 1837, Cooke and Wheatstone produced their first form of needle telegraph (Figs. 2, 3) on the galvanometer principle, in which different combinations of the right and left movements of the needle indicate the various letters of the alphabet. The current is readily reversed, so as to give these alternate movements to a magnetised needle, by moving a handle attached to the case of the instrument. This handle is attached to the cylinder, *a b*, of dry wood, supported at one end in the face of the instrument, and at the other by the support, *m*, *a* and *b* being metal rings insulated by the dry wood, and having metal studs projecting from them, one of which is shown at *e*. At *g h* are binding-screws connected with the galvanometer coils, A, and the metal springs, *c*, *i*, *k*, *f*, are so arranged that as the cylinder with its studs are turned to right or left, the current is conducted by the metal strips, one of which is lettered *d*, from the positive pole C of the battery, either from *g* to *h* or in the contrary direction. Although, as we shall presently see, other systems have come into use of late years, the needle telegraph is the cheapest and most simple form of all. It is considered to

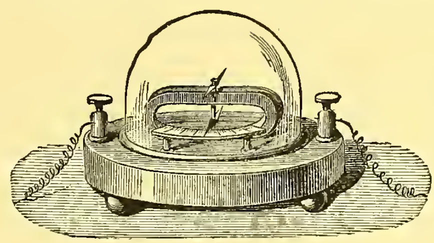


Fig. 1.—NEEDLE GALVANOMETER.

be the very best for railway work, and, as a matter of fact, nearly 16,000 of these instruments are still employed in that capacity. There are also nearly 4,000 at work for the Post Office.

Nearly all the different systems of telegraphy can be grouped under two heads. 1. Those that depend upon the tendency of a magnetised needle to place itself at right angles to a wire conveying a current. And, 2. Those which depend upon the electro-magnet. They might also be subdivided into two more groups — namely, those which give signals only translatable by a skilled operator, and those which utilise the ordinary letters of the alphabet. The needle telegraph must of course be placed in the first subdivision, for its right and left hand signs are undecipherable by any but a trained operator. To meet this difficulty, Wheatstone invented his A B C telegraph. In this instrument there is a dial, round which are plainly printed the letters of the alphabet, numerals, and other signs in common use. A movable pointer can be set by the operator to any letter required, and words are quickly spelt out. In the meantime he turns a handle with his other hand, which brings into play a magneto-electric arrangement for furnishing the necessary current. So it will be seen that the A B C instrument had two great advantages which recommended it as especially available for private lines where skilled labour was not obtainable or desirable. It could be worked by any one having a knowledge of the alphabet, and it required no battery. It has been used for years in many warehouses and offices, and although now it is being rapidly supplanted by the telephone, there were still in 1883 more than 4,000 instruments in use.

In America, the Morse system of telegraphy is almost universal, and the same system is making rapid progress in England. In this method, the electro-magnet is used in the following manner:—At the transmitting station there is an instrument called a "key" (Fig. 5) which consists of a little lever with a knob at one end. When this knob is depressed by the operator's finger, the line-wire is placed in contact with a battery. Now let us see what happens at the distant station situated at the other end of that line-wire. Directly the current passes through the wire it affects an electro-magnet (see Fig. 6). Above this magnet there is a lever, and as one end of the lever is attracted and drawn down to the magnet, the other end, carrying a little wheel charged with printing-ink, is caused to press against a travelling strip of paper. In this way a mark is left on the paper, whose length is proportionate to the time during which the current passes and the magnet is in action. It may make either a long line or only a mere spot. By combinations of short and long marks—technically called dots and dashes—the Morse alphabet is made up. Here it is :—

A . —	J . — — —	S . . .
Ä (æ) . — . —	K — . —	T —
B — . . .	L . — . .	U . . —
C — . — .	M — —	Ü (ue) . . — —
D — . .	N — .	V . . . —
E .	O — — —	W . — —
F . . — .	Ö (œ) — — — .	X — . . —
G — — .	P . — — .	Y — . — —
H	Q — — . —	Z — — . .
I . .	R . — .	Ch — — — —

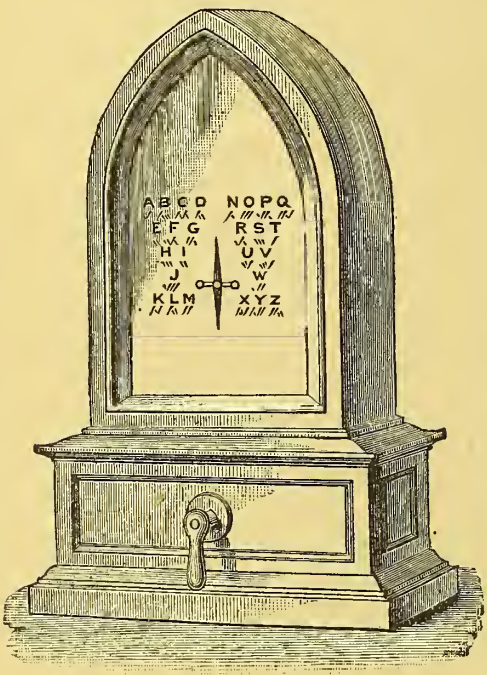


Fig. 2.—WHEATSTONE'S SINGLE-NEEDLE TELEGRAPH.

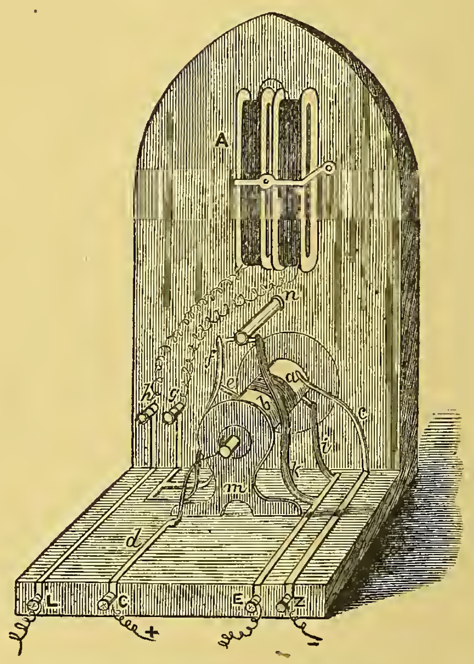


Fig. 3.—BACK OF SINGLE-NEEDLE INSTRUMENT.

The Morse printing instrument just described is a beautiful, but rather complicated piece of mechanism, for besides the printing and electric arrangements it is furnished with clockwork to keep the paper tape in motion whilst the message is being delivered. But lately these accessories have in many cases been dispensed with, and the operator depends upon his ear for the translation of the message sent. The click of the armature against the magnet is intelligible to the skilled worker; and a far more simple instrument, consisting of an electro-magnet and armature, and called the Morse *Sounder*, is now coming into extensive use. The Morse system can also, if preferred, be made to appeal to the eye, instead of the ear, by the attachment of a galvanometer needle. In such case, the right-hand movements will stand for *dashes*, or long signals, and the left-hand for *dots*, or short signals.

On long lines the current often becomes so reduced by leakage, and from other causes, that it is insufficient to work an electro-magnet, either to mark paper, or give audible sound. It is therefore usual on such lines to interpose an instrument called a relay. A current weakened by distance, although unable to effectively work the receiving instrument, may have enough force to cause a light armature to be attracted by a small magnet. This movement may be made to bring a local battery into circuit so as to strengthen the current, and such an arrangement constitutes a relay.

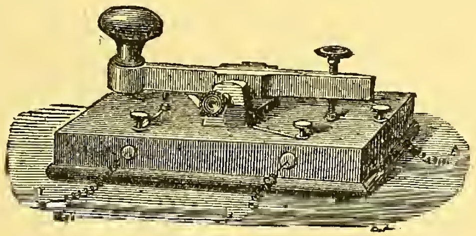


Fig. 4.—MORSE KEY.

A very ingenious form of telegraph was in operation a few years back on the South Western Railway system between London and Woking—a distance of twenty-six miles. This was Cowper's writing telegraph, by which ordinary writing at the transmitting station is accurately reproduced, line for line, at the receiving station. The process was however somewhat delicate and tedious, requiring two wires, and hence this ingenious and thoroughly efficient mode of telegraphy has not come into common use.

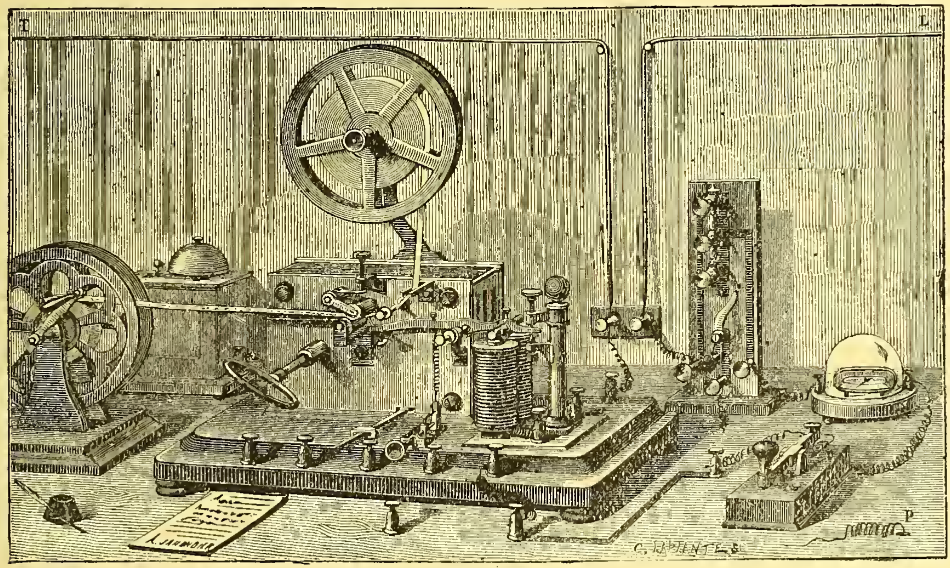


Fig. 5.—MORSE PRINTING TELEGRAPH.

The modern saying, "Time is money," is indeed most of all true when applied to telegraphic signalling; and many endeavours have been made, not only to transmit signals with celerity, but also to transmit more than one communication at the same time along the same wire. This has been successfully done in the duplex system—by which a message is sent from either end of the same wire simultaneously; in the diplex system—in which two messages can be sent simultaneously in one direction; and in the quadruplex system, which combines the two former methods, and by which it is possible to convey four signals along the same wire at the same moment. This last method was invented by Mr. Edison, whose name is now so familiar in the other branches of electrical science. It would be impossible to detail in a limited space the contrivances by which these wonderful results are achieved, but we may mention that there were in England, at the beginning of 1883, 319 duplex and 13 quadruplex circuits in use.

The last decade has seen a wonderful growth of submarine telegraphic lines, and now the world's ocean floor is covered with a network composed of more than 80,000 miles of cable. In construction, these cables are very little different from the first one ever made, which was laid between Dover and Calais. But the manufacture is so improved, and demand has brought such good materials into the market, that now a cable can be made of far greater strength and better quality. The Atlantic is now spanned by nine such links of communication, the latest one having been laid in 1882 in twelve days, without the slightest difficulty or hitch from the beginning to the end of the operation.

Land lines are carried either above ground—as we see them at the side of the railway—or underground by means of copper wires insulated with gutta percha, and enclosed in iron pipes. The latter means is most commonly adopted in towns, where the smoke would have an injurious effect upon the iron wires usually employed on overground lines. A new material, called phosphor bronze, having the strength of iron, and the conductivity of copper, is now under consideration for telegraphic purposes, and is likely to come into use.

According to Mr. Preece, the chief of the British postal telegraph system, there are in the United Kingdom 12,000 miles of underground wire, and to lay the whole system underground would cost twenty millions sterling. The money embarked in submarine cables is about £30,000,000, and a fleet of twenty-nine ships is employed in laying, watching, and repairing such lines. The growth of business since the Government took the telegraphs into their keeping has been enormous—126,000 messages per week have increased to 603,000. In press-work the increase is most noticeable, for 5,000 words per day at the time of the companies have grown to 934,154 words per day now. On the submarine lines the increase has been equally great. In 1871, the Eastern Telegraph Company dealt with 186,000 messages; in 1881 they dealt with 720,000.

CANNIBALISM.

IN considering the origin of a practice so odious as cannibalism, we must always bear in mind that a human life is not nearly so highly regarded amongst savages as amongst the civilised. Thus, the natives of Tierra del Fuego, when starving in the winter-time, would throttle and devour the oldest woman in the party rather than kill their dogs, because "dog catch otters!" The Fijians thought nothing of a human life. Every undertaking, no matter how insignificant, was preceded by human sacrifices. If the king simply launched a canoe, its deck was bathed in the blood of ten men. Murder amongst them was an exceedingly trivial offence; indeed, to be an acknowledged murderer was the object of the Fijian's ambition. For such a people to become cannibals was a comparatively easy matter; and so fond were they of human flesh that their greatest praise of anything was to say that "it is as tender as a man." They rather disliked white men, however, because they savoured so much of tobacco, which in the case of sailors is probably true. Women were preferred, especially choosing the arm above the elbow, and the thigh. In this they differed from some of the South Sea Islanders, who looked upon the palm of the hand, especially of a young girl, as the daintiest morsel, while the New Zealander gave a decided preference to the foot. At the royal feasts in Fiji the chief dish was human flesh. Slaves were also fattened up for the market, as the bodies of enemies slain in battle were not sufficient to meet the demand. The women were prohibited from eating this luxury, as it was considered too good for them. There was a bravado about the Fijian's cannibalism, too, whatever may have been its origin, and they often made a boast of the number of men they had eaten. Thus Ra Undre-Undre, chief of Rakiraki, never tired of bragging about the 900 corpses he had put himself outside of. The same bravado is seen in the case of the Red inhabitants of North America, who express their resolution of making war against an enemy in the pompous phrase, "Let us go and eat that nation;" and in asking the assistance of a neighbouring tribe, they invite it to sup broth made of the flesh of their enemies. These expressions would appear remnants of old customs, though cannibalism in the ordinary way was regarded by the Red Indians with abhorrence. When Mr. Waddington's men were murdered by the Chilcoaten Indians on the Bute Inlet Trail in 1864, their hearts were however torn out and devoured by the savages, who believed that the courage of the white man was thus imparted to them. Other tribes boil their enemies' hearts in a kettle with corn; and in a kind of mock fury drink ladlefuls of the soup—"drinking the heart's blood of the enemy." The New Zealand warrior, after killing his foe, would cut off the head, and scooping up the warm blood that was flowing from the dying trunk, turn to his enemies and drink with fiendish triumph. It is needless, however, to add anything more to the sickening horrors of cannibalism. To point out in a simple way the probable origin of the practice is what we are more concerned with here.

We must remember that in the savage state men are not so dainty as Europeans; and, indeed, to such extremities are savages often driven that nothing is too filthy for them to devour. A New South Wales native, surprised on the banks of the Hawksbury river by some of our earlier colonists, launched his canoe and left behind him a specimen of his food. "From a piece of water-soaken wood, full of holes, he had been extracting and eating a large worm. The smell both of the worm and its habitation was in the highest degree offensive." To people in this continual state of starvation the body of a man was a great windfall. Accordingly, when any one fell sick he was put to death forthwith, because if he were allowed to pine and die his flesh would be wasted. This was a very wide custom, and is noticed by Herodotus as prevailing amongst some ancient Asiatic tribes, who frequently accused a perfectly healthy man or woman of being ill for the sake of having a feast, and, despite all protestations to the contrary, hurried them off to execution. The same goading spur of necessity has driven members of even civilised communities to practices equally abhorrent, as is seen from the records of besieged towns and of shipwrecks. Mothers have been constrained to take the suckling from their breast to devote it to the satisfying of the cravings of hunger, and all natural affection and friendship have been swallowed up by the promptings of self-preservation.

Indeed, some competent authorities go so far as to say that few races have been altogether exempt, at some period or another of their existence, from cannibalism. In our own island the archæologist has found human bones under circumstances sufficiently suspicious to be taken by many as evidence that our forefathers were cannibals, On the authority of Diodorus and Strabo, the ancient inhabitants of Ireland are credited with an affection for the flesh of their deceased relatives. St. Jerome tells us, also, that he had himself seen the *Attacotti*—a Scotch tribe—feed upon human flesh, and with needless detail he says that when he was a little boy living in Gaul, he observed that the inhabitants often preferred a ham of the herdsman to a shoulder of mutton, the daintiest morsel of all being a female's breast fried! In so recent a time as the French Revolution, we read that one of the mob plucked out the heart of the Princess Lamballe, took it to a restaurant, where he cooked and ate it. And only five years ago the present writer met a sailor who, with four others, had consumed—under heart rending circumstances certainly—the dead body of a comrade.

Necessity, then, may be taken generally as the originating cause of cannibalism. But according to a very widely prevalent view that the flesh of animals becomes substantially less nourishing as we descend in the scale—mammals being more nourishing than fishes, whence arises the custom of eating fish amongst Catholics as being the next thing to fasting—its votaries have gone so far as to allege that cannibalism confers a pleasure connected with the sense of taste unknown to those that confine themselves to brutes. Bacon, speaking of cannibals, says that "they feed not ordinarily upon men's flesh, but reserve it as a dainty." Certain it is that in many known cases the fondness of savages for human flesh was so great, that kidnapping the members of one's own tribe was not uncommon, and even members of the same family were scarcely safe from one another. There is a tradition amongst the Papuans that if a fat man went to the island of Tapuæmanii, or happened to be seen on the lowland on the reef, *he was seldom ever seen again*. It is easy to see that when a taste for human flesh in any tribe had been developed to this extent, no sacrifice to the gods would be considered so acceptable as human flesh. It was not the life of the victim that was offered up—a human life in the eyes of a savage is not worth making an offering of: it was *the flesh*. The gods were man-eaters, and descended upon the bodies of the human sacrifices, and consumed them in the form of birds. In many cases the priests, who represent the gods, consume this flesh, and indulge in rites too ghastly for our pen to entrench upon. Suffice to say that the origin of human sacrifices seems to have been in cannibalism, for it is human flesh that is offered up, not human life. When men offer up sacrifices, it is generally those things that are prized most highly. A life to a Fijian is nothing, as we have seen; the flesh, however, is everything. Of course, at a later stage, when men have ceased to be cannibals, and yet continue to immolate human beings, these immolations have lost their significance, and very rapidly cease to be practised. Facts might be adduced in abundance to support the view here laid down; we have, however, dwelt long enough upon this picture, which, though dark and repulsive enough, is certainly not without instruction for us whose necessities, fortunately, are not so urgent as those of many of our less happy brethren.

A MINIATURE RAILWAY.

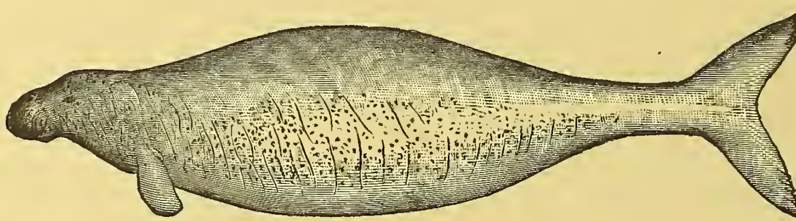
A CURIOUS model of one of the characteristic features of modern civilisation may be inspected in the grounds of a Derbyshire justice of the peace, Mr. A. P. Heywood, the occupier of Duffield Hall. The object is a miniature railway, over and under ground, where an example of every engineering difficulty encountered in the construction of an ordinary railway system has been artificially created, so as to illustrate the working of this as completely as possible. In gauge, the line is but fifteen inches, and is laid partly with steel and partly with iron rails, of a rate varying from 9 pounds to 12 pounds per foot. In length, it is a little short of a mile, and has many curves. On the way there are the features of embankment, cutting, bridge, a viaduct 22 feet in height, a tunnel hewn out of solid rock, points, crossings, and, lastly, a number of picturesque stations, named according to the nature or position of the ground. Passengers may get out at the Tennis Lawn, the Wood, the Manor Copse, or other convenient stations, the first named being the central one. Mr. Heywood is a skilled workman, and has accomplished the task of putting together the rolling-stock without much aid.

THE EXTINCT SEA-COW.

About midway between the Aleutian Islands and the coast of Siberia is situated Behring's Island, a locality which, with respect to both its geography and natural history, is one of the most remarkable in the North Pacific. Here the famous voyager Behring died, in the middle of the eighteenth century, during his third and, as far as he was concerned, most disastrous voyage. A naturalist, named Steller, was one of the companions of the explorer, and to him we are indebted for a most accurate and complete description of an island which until then had not been visited by civilised man. Among the animals described by Steller as abounding on the coasts, but no longer found there, or anywhere else, is the sea-cow (*Rhytina Stelleri*). From his account it seems to have been generally of a dark brown colour, although some specimens had large white spots and streaks. The heavy leathery hide was covered with hair so thickly that it had all the appearance of an extra skin, which in texture and feeling was like the bark of an old oak-tree. This hair, when examined, was found to be alive with vermin. The full-sized animals were from thirty to thirty-five feet long, and weighed from three to three and a half tons. The head was small, the neck short, and the body diminished rapidly behind, like that of a seal. The fore legs were short, and terminated without fingers or claws, but were thickly overgrown with strong hairs ; the hind legs were replaced by a tail-fin, like that of a whale. The mouth was prolonged, and instead of teeth the creature had two large masticating plates. The udders of the female were placed between the fore legs, and both flesh and milk resembled those of horned cattle ; indeed, in Steller's opinion were much superior. It is evident that the animal belonged to the great seal family, though of the most gigantic size.

The sea-cows fed on the sea-weed which grew abundantly on the coast. In feeding, they moved the head and neck like an ox on shore. Every few minutes the animals raised their noses above water to blow out air and a little water through the mouth. While pasturing they could be approached without difficulty, and were not frightened by the presence of man. They appear to have been gregarious, and manifested great attachment to each other. When one was harpooned the others made almost incredible exertions to rescue it.

Later travellers scarcely mention the sea-cow. In an account of Behring's Island, published in the beginning of the present century, it is recorded that though sea-cows were very numerous when the island was first discovered, yet that none were at this time to be seen, the last having been killed in 1768. During the voyage of the *Vega*, Professor Nordenskjöld made special inquiries on the spot, and on comparing the various accounts, he arrived at the conclusion that sea-cows were killed as late as 1780 ; that the heart only was eaten, and that the skin was used for covering the "baydars," or Russian coast-boats. The skin was so thick that the inhabitants were accustomed to split it in two, and the pieces thus obtained were amply sufficient to cover a "baydar" 20 feet long, 7½ feet broad, and 3 feet deep. Two natives reported in 1854 that they had seen, on a retired part of the shore, an animal altogether unknown to them ; and their description, corresponding in many points with Steller's, makes it probable that sea-cows were really in existence at that time. The report stated that the animal was very thick before and small behind ; that it had small fore legs, was brown in colour, and had lighter spots all over its exposed portion. It had no back fin, and when it raised itself to "blow," the ribs could easily be counted, the backbone being especially noticeable, on account of the creature's great leanness. It seems then most probable that these *Rhytina* herds were driven away from their special pasture-lands, and were unable to maintain the struggle for existence. The unusual form almost indicates that this was the last representative of a group destined to become extinct.

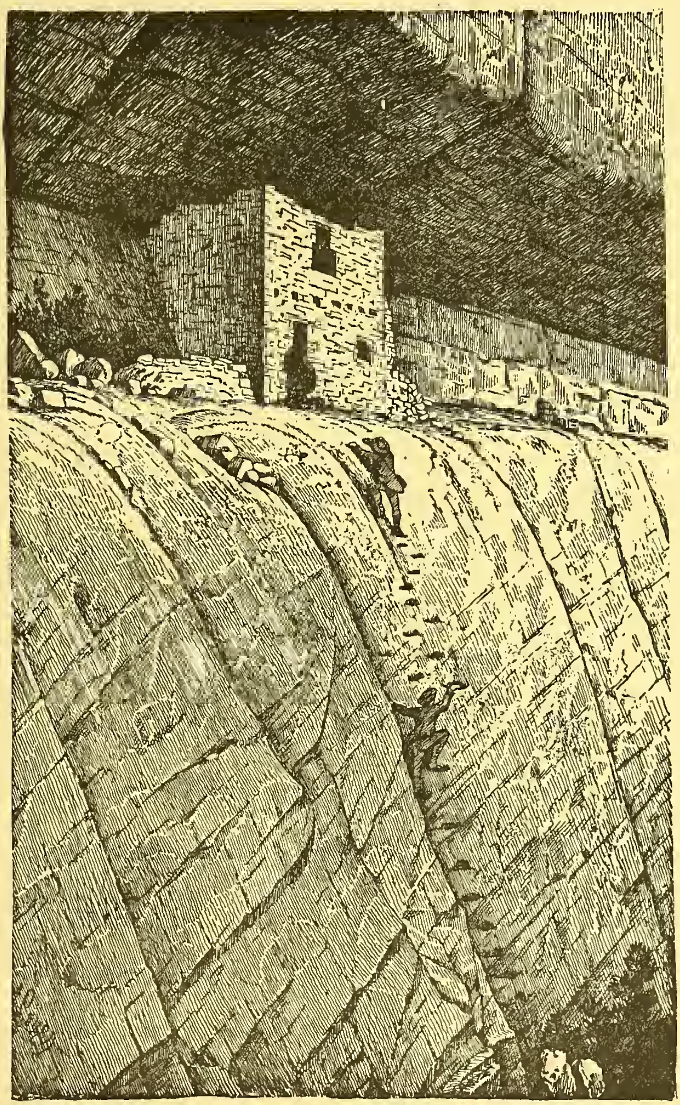


SEA-COW (RESTORED).

A large and nearly-complete collection of bones was obtained from a bank about six or seven feet above the sea-level, and covered by earth to a depth of eighteen inches. The ribs, on account of their fine quality, have been used for the runners of sledges and other purposes. From these bones there has not been much difficulty in reconstructing the annexed figure of this little-known animal.

THE AMERICAN CLIFF-DWELLERS.

As year after year goes by, and as the footstep of the white man penetrates farther and farther into the *terra incognita* of the Western hemisphere, it becomes more and more evident that the continents of America have been the seat of a civilisation almost as ancient, if not so highly developed, as is to be met with in the so-called Old World. First, the stupendous ruins of the palaces and temples of Mexico and Yucatan, and then the massive and innumerable mounds of the Mound-builders, were described by enterprising travellers to an almost incredulous circle of readers. And at length we have descriptions of the remnants of human handiwork as immense as are any of the remains of Mexican palace or Mississippi mound; while conjectures as to the condition of the people who once inhabited these ruined dwellings are, if possible, more futile even than those concerning the other ancient nations of America.



CLIFF DWELLING ON THE SIDE OF THE CAÑON OF THE CHELLY, A BRANCH OF THE SAN JUAN.

The ruined habitations of the Cliff-dwellers are met with in the almost unexplored territory of New Mexico, Arizona, Nevada, Colorado, and Utah. Lying between the Rio Mancos, the La Plata, and the Rio San Juan, is an area some six hundred square miles in extent, which is remarkable for the almost total absence of water, and the consequent stunted and sparse growth of the vegetation which it supports. Barren and desolate as is the land of the Cave-dwellers at the present day, however, the indications are sufficiently clear that it was not always so. The country is broken up by immense cracks and fissures, sometimes many thousands of feet in depth, forming cliffs of the most stupendous height, and of apparently inaccessible steepness. These cliffs are sometimes composed of limestone, sometimes of sandstone, with alternate layers of shale or clay. The soft layers thus imbedded in the harder rock are gradually worn away by the action of the rain and winds, leaving open caverns, the roofs and floors of which are formed by the solid stone ledges above and below. The Cliff-dwellers were accustomed to take advantage of this natural formation of caves, the front of which they walled in, forming comfortable and sheltered, but often extremely diminutive, habitations.

But the buildings were not confined to these simple edifices. Though such habitations are very numerous upon the face of many of the cliffs, there are also to be seen upon the terraces of the more open cañons, buildings of a more imposing elevation, while in the bottom-lands, just above the banks of the San Juan and the La Plata, are to be found the remains of extensive towns, doubtless also the work of the Cliff-dwellers. On a ledge of rock some thousands of feet above the bed of the Rio Mancos is one of these settlements, where the houses are built as closely together as the nature of the ground admits, and are in such numbers as fully to warrant the name of town which has been applied to it. There is no possible means of access to this ledge from above, owing to the projection of the rocks; while from below, though traces still remain of rude foot-holes and sloping paths, no one would now venture to scale the dizzy heights presented by the almost perpendicular face of the cliff.

Among the earliest of the buildings of the Cliff-dwellers described was one upon the banks of the River Animas, which contained no less than 500 rooms. The building was, of course, in ruins, the roof and portions of the walls having long since crumbled away, yet many of the apartments were still well preserved, and showed that they were lighted by small windows, but possessed no external doors. Indeed, all the buildings of the Cliff-dwellers, whether built upon the rocky ledges of the cañons, upon the bottom-lands by the river-side, or in the natural caverns already described, seem to have been accessible only by means of ladders, which no doubt rested on certain still existing niches, and were drawn in when the occupants had reached the shelter of their dwelling. This Animas building appears originally to have been of four storeys, and the floors were formed of massive beams of cedar, sometimes nearly a foot in diameter, the interstices between which were filled up with smaller branches and twigs, while the whole was covered with a felt of cedar-bark. Nothing could more clearly indicate than the size of these cedar-logs the change that must have come about in the climate of the country since the time of the Cliff-dwellers. Not a tree now is to be found within hundreds of miles of the district of a size approaching to that of the logs so freely used in many of these buildings, nor would the present soil and climate support such vegetation as must have prevailed during the period of these strange and now forgotten people. Within a few hundred yards of the above was a second large house, and between the two were ranged a large number of small buildings, which obviously had in happier days been a not inconsiderable village. These cottages were built of small rounded boulders laid in a cement of sun-dried clay, and were consequently in a more advanced state of ruin than the larger buildings, which were constructed of solid masonry.

As with so many of the archaic relics of America, it is almost impossible to estimate the date of these ruins. Nothing can be based upon the fact that the timber of which they are constructed is often still perfectly sound, for in the dry atmosphere of the San Juan there can hardly be a limit to the duration of seasoned timber. Nor, on the other hand, can any very conclusive data be gained by a consideration of the vegetation which now covers the ground, and has in many cases overgrown the buildings of the ancient Cliff-men. But when we consider that the land was once probably covered by well-grown pine-trees, which have slowly given place to the present scanty growth of piñon and juniper—when we consider that the dwellings of the Cliff-men had to be erected, dwelt in, abandoned, and forgotten, and then in turn buried beneath a growth of stunted shrubs, after the lapse of probably many centuries—it becomes indeed difficult in the extreme to form any estimate of the probable date of the era during which they lived and flourished, and evolved their primitive, yet in some respects advanced culture.

As has been said, the houses are often gathered together in large numbers on the elevated ledges of the cliffs; one of these villages extended to a length of 545 feet, the greatest height of any of the buildings being 40 feet. Single dwellings are also found, like that shown in the illustration, which could only be reached by its explorers in the most hazardous manner. Most of the houses comprise a ground floor and a single raised storey, and the walls are usually of but insignificant thickness, some attaining nearly eighteen inches, but frequently not exceeding six inches. The walls are generally carefully plastered both on the interior and exterior surfaces, and here and there the imprint of a small extended hand remains to prove that this plastering is really the handiwork of a long-forgotten race. Behind the houses were two reservoirs, doubtless intended to store water for the use of the settlement; while here and there traces can still be seen of small corrals, in the interior of which yet remain small deposits of manure and other rubbish. The presence of these corrals raises another question which has hitherto bid defiance to archæologists. How were the animals which formerly occupied them carried up the steep sides of the cliffs? and by what means were they supported when thus removed from any but the most precarious pasture? The first question appears insoluble.

In the immediate vicinity of nearly all the cliff settlements are found certain round towers, to which the Spaniards have given the name of *estufas*. These towers are remarkable for the solidity of their construction, being sometimes as much as sixty feet in diameter, and containing a number of small cells, or chambers, which were doubtless used as store-rooms, in which to place the treasure of the tribe, when attacked by an enemy. But the chief use of not a few at least of these towers seems to have been the protection of the sacred fire, the extinction of which, even for the shortest period, was supposed to bring down the heaviest misfortunes upon the whole tribe. Accordingly a small chamber, partly sunk beneath the level of the earth, is often met with in the very centre of the *estufa*, the entrance to which is described as measuring only twenty-two inches in breath by thirty inches in height.

That the Cave-men were dislodged from their apparently impregnable positions by incursions of barbarians can hardly be doubted; and it is curious to observe that, according to more than one traveller, the ground in front of many of the buildings is covered with arrow-heads, the points of which are almost invariably directed against the walls of the houses. Whether or not they are the signs of the last fatal attack upon a peaceful people previously driven to the shelter of these inaccessible rocks, no one can at present say.

Strangely enough, not a trace has hitherto been met with of the use of metal amongst the Cliff-men, though it is improbable that a people in other respects so highly civilised should have remained utterly ignorant of so invaluable an aid to industry. Possibly their metal implements and ornaments, if such they possessed, have been removed from the ruins by wandering Indians during the course of ages, or were carried off by those besieging barbarians to whose attacks the extinction of the Cliff-dwellers has been attributed.

The Cliff-men were by no means deficient in art, though this was of a rude and primitive type. The walls of many of their houses, and even cave-dwellings, are covered with hieroglyphics, or at least picture-writings, which unfortunately are as a sealed book to us. It cannot be said that in these picture inscriptions any high degree of artistic excellence is displayed, yet it is easy to recognise many of the objects pourtrayed, though impossible to interpret their signification. Their pottery is often of good form and beautiful design. It is thin and hard, and is decorated sometimes by raised ornaments, sometimes by painted patterns, the colours of which are as fresh and brilliant to-day as when originally manufactured—who knows how many centuries ago? The remains of this pottery are very plentiful, one traveller stating that the fragments lie about in "cart-loads," while Colonel Holmes tells us that within an area of ten square feet he had gathered up the fragments of no less than fifty-five different vessels—vases, or amphoræ, bottles, and dishes. Strangely enough, pipes, which are so common amongst the Mound-builders, are of the rarest occurrence in these ruins.

As to the customs of the Cliff-men, it may be conjectured, from the remains of charred corn and maize-heads which have been found in the ruins of their homes, that their lives were to a great extent agricultural. Holes in the walls show where the beams of their looms were formerly supported, while in the central chamber of many of the houses may be seen a depression bearing the traces of fire, and the flat stones upon which their cakes were baked still lie amongst the refuse ashes. Sheep they seem to have roasted in pits covered with hot ashes, and bones of these animals remain in heaps, to prove that the Cliff-man was not altogether indifferent to the pleasures of the table.

Notwithstanding the numerous remains of this ancient people, it cannot be said that a single skeleton of a Cliff-dweller has ever yet been found. Here and there, indeed, a few human bones have been discovered, which at the first glance appeared to belong to them, but evidence afterwards arose proving them of much more recent date, and we can only suppose that the habit of cremation, so universal amongst fire-worshippers, has effectually destroyed every record of the physical characteristics of a people who at one time must have played a not inconsiderable part in the history of their country.

REMARKABLE SEVENS.

MUCH has been written upon the prominence which the number seven has had in human thought and history from the earliest times, and few have disputed that *some* primitive tradition must have lain at the bottom of it. Without discussing this point, it will be interesting to enumerate some of the things, events, or ideas, which naturally group themselves with the mystic number. In one or two cases, no doubt, the number is accidental, but they add to the interest of our catalogue. It is almost needless to say that more could be added to the list easily.

THE SEVEN DAYS OF THE WEEK.

Sunday.—From the worship of the sun. *Monday.*—Because on this day the ancients worshipped the moon. *Tuesday.*—From being sacred to Tuesco. *Wednesday.*—The time appropriated to *Woden*, the chief idol. Woden is another form of *Odin*, the principal god of the Scandinavians. *Thursday.*—So called from *Thor*, who was the son of Odin, and god of war. He was said to possess a belt which doubled his strength whenever he put it on. *Friday.*—From Friga, or Frea, the wife of Odin. *Saturday.*—From *Seatur*, thought to be Saturn, the god of time.

SEVEN MONTHS HAVING THIRTY-ONE DAYS.

January.—From Janus, god of the year. *March.*—From Mars, god of war. *May.*—Derived from a Latin word, meaning—to grow. *July.*—From Julius Cæsar. *August.*—So called to honour the

Emperor Augustus I. *October.*—So called from being the eighth calendar month, according to the Roman calendar. *December.*—From Decem, tenth.

THE SEVEN COLOURS OF THE RAINBOW.

1. Orange; 2. Red; 3. Yellow; 4. Green; 5. Blue; 6. Indigo; 7. Violet. These properly mingled make white.

THE SEVEN NOTES OF THE SCALE.

A, B, C, D, E, F, G, in English; Do, re, mi, fa, sol, la, si, in Italian.

THE SEVEN WONDERS OF ANTIQUITY.

The Colossus.—This was at Rhodes, and represented an image of the Sun, or Apollo, 126 feet high. It was destroyed by the Saracens when they took Rhodes. *The Pyramids.*—Of Egypt, the largest built by Cheops. *Diana's Temple.*—At Ephesus, built by Ctesiphon. *The Mausoleum* of Mausolus, king of Caria, built by Artemisia, his queen. Some portions of this sepulchre are now in the British Museum. *The Walls of Babylon and its Hanging Gardens. Statue of Jupiter*, at Elis, in Peloponnesus, by Phidias, 50 cubits high. *Pharos.*—A watch-tower of Ptolemy Philadelphus, on the small island of Pharos, in the Bay of Alexander (Alexandria). Pharos was built of white marble, seen 1,000 miles off; fires were lighted on the top to warn travellers of the difficult access to the bay.

THE SEVEN WONDERS OF HISTORY.

1. The Coliseum at Rome; 2. The Catacombs of Alexandria; 3. The Great Wall of China; 4. Stonehenge; 5. The Leaning Tower of Pisa; 6. The Porcelain Tower of Nankin; 7. The Mosque of St. Sophia at Constantinople.

THE SEVEN SAGES OF GREECE.

Thales.—Founder of the Ionic philosophy. Born at Miletus, B.C. 640. He was the first who observed the apparent diameter of the sun. He also observed the nature and course of eclipses. 2. *Solon.*—His advice was, "Consider thy end." He was born in the Island of Salamis about B.C. 638. 3. *Philo.*—He said "Know thyself." 4. *Pittacus.*—Said "Love your friend as if you expected him to be your enemy." He formed a code of laws in verse, thinking that perhaps in this form they might be more easily remembered. 5. *Bias.*—He said, "There is nothing better than moderation." 6. *Cleobulus.*—These were his maxims: "Do good unto your friends that you may attach them to you the more; do good unto your enemies that you may make friends of them. 7. *Periander.*—It was by his flatterers that Periander is reckoned among the "seven sages;" he was a very cruel man. He put to death his wife, and then banished his son for mourning over the fate of his mother.

THE SEVEN CELEBRATED CITIES OF ANTIQUITY.

Rome.—Built by Romulus, its first king. *Athens.*—Founded by Cecrops. Athens was originally called Cecropia, in honour of its founder. Cecrops introduced agriculture, and the rites of marriage and burial. *Nineveh.*—This city received its name from Ninus, one of its kings. Ninus fell in love with Semiramis, the wife of one of his generals; and after the death of her husband he married her. She is supposed to have afterwards poisoned Ninus. He reigned fifty-two years. *Babylon.*—Called "the hammer of the whole earth." *Jerusalem.*—The ancient Jebus. *Tyre.*—Famed for its beautiful dye. *Carthage.*—Founded by Dido. Site of the modern Tunis.

THE SEVEN KINGS OF ROME.

Romulus.—Worshipped as Quirinus. *Numa Pompilius.*—Introduced Termini, and built a temple to Faith, and also the temple of Janus. *Tullus Hostilius.*—Burnt to death in his palace. *Ancus Martius. Tarquinius Priscus.*—He built a magnificent temple to Jupiter. *Servius Tullius.*—Slain by Tarquin the Proud. *Tarquinius Superbus.*—The last king of Rome.

THE SEVEN HILLS ON WHICH ROME STOOD.

1. The Palatine; 2. The Capitoline; 3. The Aventine; 4. The Quirinal; 5. The Cælian; 6. The Viminal; 7. The Esquiline.

THE SEVEN HILLS OF LONDON.

Cornhill, Snowhill, Holborn Hill, Ludgate Hill, Fish Street Hill, Bread Street Hill, Tower Hill.

THE SEVEN KINGDOMS OF THE HEPTARCHY.

1. *Wessex.*—Founded by Cerdic. 2. *South Saxony.*—Founded by Ella. 3. *Kent.*—Founded by Hengist. 4. *East Saxony.*—Founded by Ercenwin. 5. *East Anglia.*—Founded by Uffa. 6. *Mercia.*—Founded by Cridda. 7. *Northumbria.*—Founded by Ida.

THE SEVEN UNITED PROVINCES.

Holland, Friesland, Utrecht, Guelderland, Groningen, Overyssel, Zealand.

THE SEVEN DIFFERENT LANGUAGES SPOKEN BY QUEEN ELIZABETH.

1. *English.*—The most copious. 2. *Greek.*—The most sublime. 3. *Latin.*—The most majestic. 4. *French.*—The most elegant. 5. *Dutch.*—The most harsh. 6. *Italian.*—The softest. 7. *Spanish.*—The most pompous.

THE SEVEN FOLLIES OF SCIENCE.

1. The multiplication of the cube; 2. The quadrature of the circle; 3. The philosopher's stone; 4. The elixir of life; 5. Perpetual motion; 6. Magic; 7. Astrology.

LIVING BEINGS IN WATER.

A POPULAR notion exists that the water we drink swarms with myriads of animalcules, and teems living beings appear within its limits. Occasionally, also, in the sediment which is deposited from water in cisterns, lakes, and ponds, we may find abundance of animal and plant life · and, as will be

Fig. 1.—SEDIMENT OF WATER FROM THE THAMES.

1. Daphnia pulex. 2. Chilodon. 3. Paramœcium. 4. Acineria incurvata. 5. Paranema globulosa. 6. Cercomonas. 7. Actinophrys sol. 8. Amœbæ. 9. Amœba diffluens. 10. Protococcus pluvialis. 11. Diatoms. 12. Desmids. 13. Confervæ. 14. Spores of fungi. 15. Remains of vegetable tissue. 16. Large Amœba. 17. Cyclops quadricornis. 18. Cypris. 19. Anguillula fluviatilis.

with multitudes of beings, invisible to the naked eye. As a matter of fact, whilst water of ordinary kind may and does contain living forms, pure water is very far from being an infusion of animal or vegetable life. It is when water has been allowed to become stagnant, and when vegetable or animal matter has been located therein, that crowds of shown in our illustrations, a very fertile field for microscopic study may be found within the compass of such deposits. The living beings found in water, it should be noted, are by no means invariably of the lowest grade. The lowest animals are collectively named *Protozoa*, and number amongst their ranks such animalcules as the *Amœba* (Fig.

1, No. 16), or the *Infusorian* animalcules (Nos. 2, 3, 4, 5). Such organisms are often plentifully found in water sediments. But other forms of life, belonging even to a class so high in the scale as the *Crustacea* (or that including the lobsters and shrimps, &c.), may be seen disporting themselves. Thus the *Daphnia pulex* (Fig 1, No. 1) and the *Cyclops* (Fig. 1, No. 17) illustrate the latter class. These beings are popularly named "water-fleas," and as they are visible to the naked eye amidst the water, their active movements in swimming can usually be discerned with clearness.

A natural inquiry may be raised respecting the power of contamination which such organisms may possess. It is an undoubted fact that the minute entered the river, literally swarmed with these organisms. At Kew, where the water was free from sewage, they were almost entirely absent. Although these observations would seem to associate the animalcules and putrescent matter, yet it was not proved that their presence was indicative of any power in the water to produce disease. The fixed "bell animalcules" (Fig. 6, No. 5), may be found in clear waters; and as regards the water-fleas already described, their presence has even been held to indicate the purity of a water, inasmuch as they occur in even the purest streams. As a matter of fact, however, it may be said that the freer from animal or plant life a water is, the greater must be its purity. It is in the *sediment*

Fig. 2. FROM THE SEINE AT PORT À L'ANGLAIS.

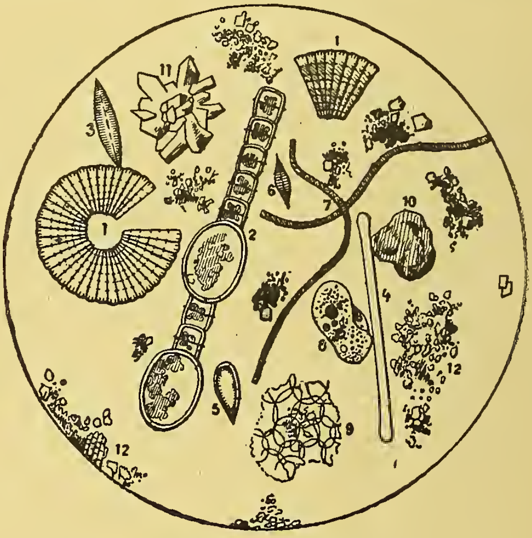


Fig. 3.—FROM THE VAUNE.

Bacteria, or organisms which cause fevers, &c., may be, and often are, obtained by human beings from impure water. It is extremely difficult, however, to detect such minute beings in the water we drink; and unless water has been contaminated from an infected source, it may be doubted whether such *Bacteria* are to be found at all in ordinary drinking or river waters. In ordinary waters there are usually to be found crowds of the little plants known as *Diatoms*, such as are depicted in Fig. 2, in large numbers, but these are absolutely harmless to animal life. The Amœbæ (Fig. 1, Nos. 16 and 9) show that possibly there may be some decaying matter in the water; but although they do not occur in clear waters of first-class nature, their presence has not yet been associated with disease.

Infusorian animalcules, and particularly the *Paramœcium* (Fig. 1, No. 3), are often found in great quantities in water. In 1850, Dr. Hassall noticed that the Thames below Brentford, where sewage

especially, which accumulates where cisterns are not attended to, or in water which contains decaying vegetable matter, that both animal and plant life flourishes.

Referring now to the illustrations, we find in Fig. 1 a microscopical enlargement of a small drop of sediment from London water. Here are seen, firstly, the water-fleas, Daphnia (No. 1), Cyclops (No. 17), and Cypris (No. 18). These active little beings flit through the water, swimming actively by means of their tail or feet. The females, as shown in No. 17, bear outside egg-sacs, in which the eggs are contained and developed. In No. 18, the *Cypris* is seen to be enclosed in a kind of double shell, whilst the *Daphnia* (No. 1) is known as the "branched-horned water-flea," from the divided character of its feelers or *antennæ*. The *Infusorian animalcules* (Nos. 2, 3, 4, 5, 6,) belong to the lowest animals. Here the body is fringed with the delicate processes called *cilia*, which possess a power of incessant movement, and which thus by their actions propel these beings through the water. These Infusorians vary from the $\frac{1}{400}$th to the $\frac{1}{5000}$th of an inch in length. The curious "sun animalcules," or *Actinophrys* (No. 7), are a near relation of the Amœba, and throw out from their bodies stiff filaments of their living substance, a *protoplasm*, from which peculiarity their popular name has been derived. The *Amœbæ* (Nos. 8, 9, and 16) are amongst the most interesting of all organisms, for they consist each of a minute speck of protoplasm, which is perpetually changing its shape, and which engulfs food-particles by throwing its soft body around them.

Lower forms of plant-life come next in order. The *Protococcus pluvialis* (No. 10) is a minute form of lower plants, which consist each of a single cell. The red snow plant, which dyes the snow of the Arctic regions of a deep red hue, belongs to this group. The Diatoms and Desmids (Nos. 11 and 12) are specks of living matter, which enclose their bodies in cases of flinty matter, and which often exhibit sculpturing of the most beautiful kind on the outside of these cases. The *confervæ* (No. 13) are represented by the lower plants, which, in the form of the "green mantle of the stagnant pool," so commonly attract our notice in the warm months of summer. The *spores* or germs of fungi are figured at No. 14, and one of the curious "water-eels," allied to the vinegar-eels (seen in sour paste and vinegar) is also shown at No. 19. These latter forms belong to the group of curious worms named *Nematoids* by zoologists.

The microscopical examination of the waters of other countries reveals certain similarities to that of the Thames, whilst in some regions the waters exhibit special characters. In Fig. 2 the water of the Seine is shown at Port à l'Anglais. Here the prevailing features are seen to consist of crowds of Diatoms (Nos. 1, 7, 8, &c.) with *Infusorian* animalcules (Nos. 19, 20), a water-flea (No. 23), a water-worm (No. 17), lower plants (No. 10), and other forms of vegetable life. In the waters of the Vaune (Fig. 3) we discern an absence of animal-life, but instead we find a rich sediment of plant-matter. Diatoms (Nos. 1, 3, 5, 6) are abundant, the intricacy of the pattern in the case of No. 1 being clearly shown. In Fig. 3 part of a Conferva, in the course of reproduction, is also seen, whilst the broken-down tissues of leaves and other plant-*débris* (Nos. 9, 10, 12) show this water to be largely impregnated with plant-life. The well-water of Grenelle (Fig. 4) is still more distinctive, since we see therein the growth and propagation of some lower forms of *fungi*. The long-branching threads (No. 2) are highly characteristic of plant-life of this description, whilst scattered through the water are the spores or germs, which are destined in due time to give origin to other fungoid growths. The Seine water at Chaillot (Fig. 5) resembles that depicted in Fig. 2. Animal and plant life are here found in abundance. The curious water-worm (No. 9) reappears here, making its way through a literal forest of vegetable matter, and a huge water-flea (No. 7), viewed from its under surface, is also depicted. The Diatoms (Nos. 2, 3, 10) are plentiful, and vegetable matters of higher kind are represented in this sediment. The water of Arcueil (Fig. 6) contains vegetable matter ; but, in addition, we find the curious fixed "bell animalcules" (No. 5), which possess crowns of the *cilia* already

Fig. 4.—FROM A WELL AT GRENELLE.

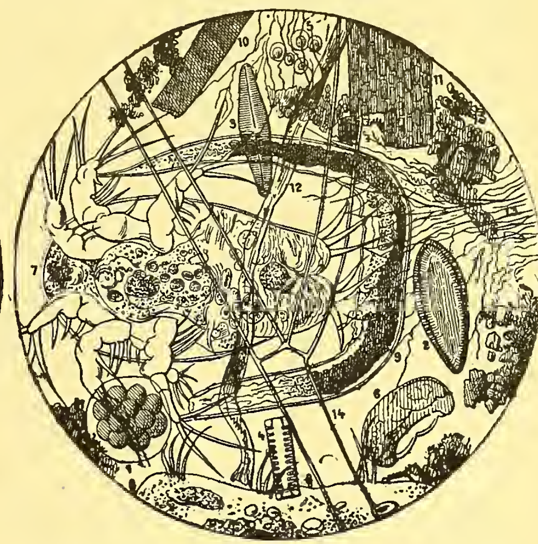


Fig. 5.—FROM THE SEINE AT CHAILLOT.

mentioned, and which sweep food-particles into their mouths by means of the waving of these filaments. Plant-spores (No. 11), and probably part of a curious form of animal-life allied to the Sea-mats, or *Polyzoa*, is shown at No. 3 in Fig. 6. The water of the Marne (Fig. 7), brings us face to face with curious rhizopods (No. 9), known as *Radiolaria*, while the Diatoms reappear (Nos. 1—4) therein; but lower plant-life comes to the front in the Dhuis water (Fig. 8), wherein we find fungous growths and the budding branches of plants belonging to this tribe. Deep down in the water of an artesian well at Passy, near Paris, vegetable life seems to find its way. Here the contamination must have found its way either from the adjoining soil, or have been blown into the water from above. The vitality of these lower forms of plant-life is surprising even to those who are best acquainted with the nature of animal and plant life. But the examination of these waters may serve to show us, besides, the wide variety of life which may be represented in a water-drop, and which exists, as a rule, all unknown to and unsuspected, even by the world of thinking persons which rightly regards water as a prime necessity of healthy life.

Fig 6.—FROM ARCUEIL, NEAR PARIS.

Fig. 7.—FROM THE MARNE.

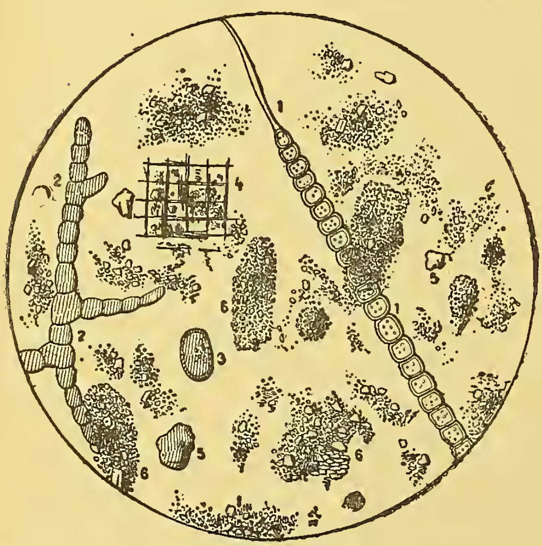
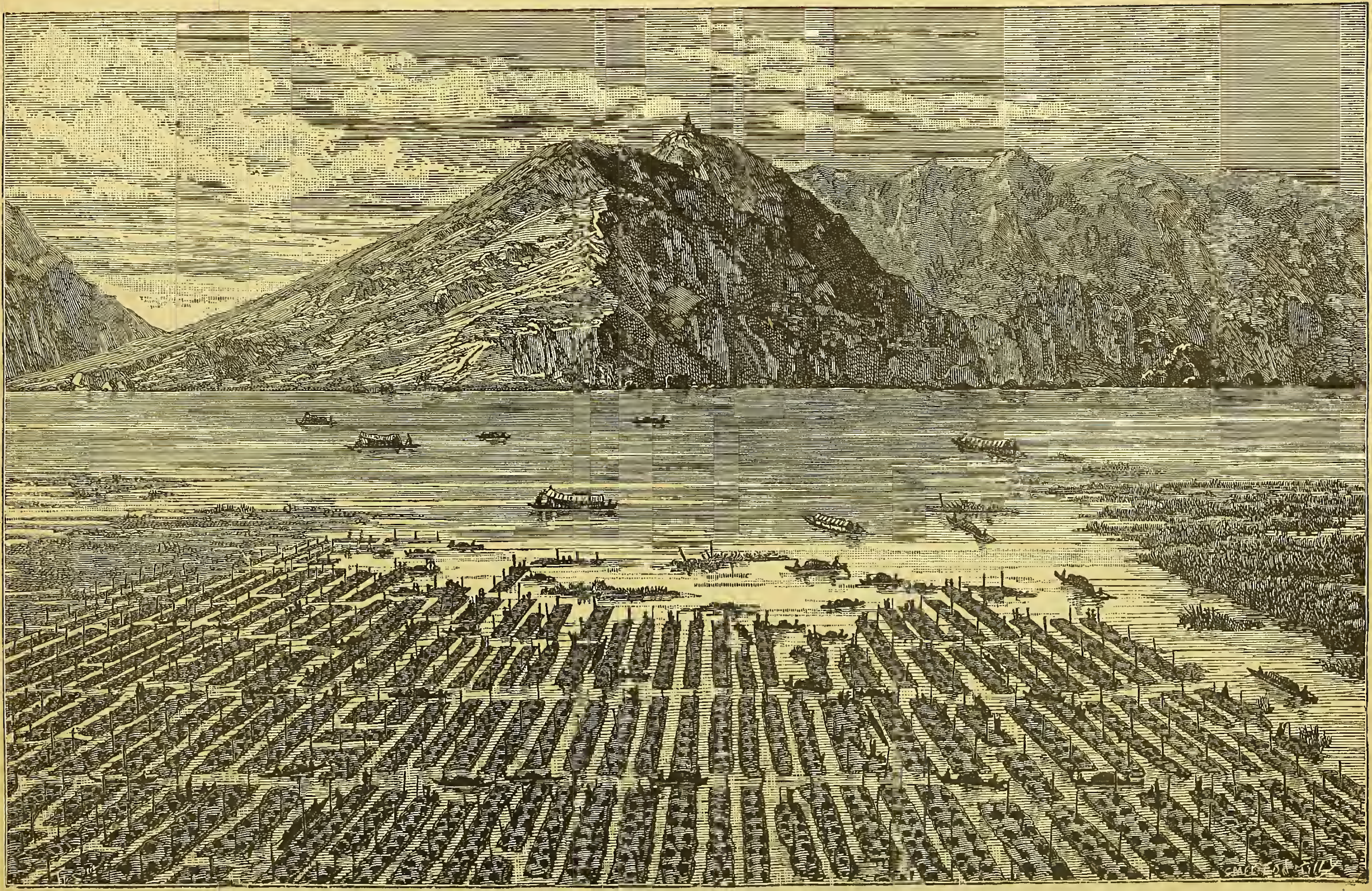


Fig. 8.—FROM THE DHUIS.

Fig. 9.—FROM AN ARTESIAN WELL AT PASSY.



THE FLOATING GARDENS OF KASHMIR.

FLOATING GARDENS AND FIELDS.

AMONGST the most remarkable illustrations of human energy, industry, and ingenuity are the floating fields and gardens which exist in the valley of Kashmir, in Eastern Asia, and on Lake Tezcuco, in the valley of Mexico, America.

In the country separating India and China there is much that moves the traveller's wonder, but nothing, perhaps, more interesting than the constructions shown in our engraving—the floating gardens on the lake, or Dol, by the little old city so famous for its shawls, called of old Srinagar, and now known as Kashmir. The beautiful expanse of water is situated at the foot of the hill called the Hari-parbat, or Kohi-maran. It is about nine miles in circumference, and in shape almost circular. Towards the hill it forms several canals, of which the chief, Raini-war, flows westward, receiving the water of other smaller canals. Most of these canals have been faced with stone, and a large portion of this material appears to have been derived from ancient Hindu temples, the sculptured surfaces having been turned inwards. The air and soil of Kashmir derive superabundant moisture from the snows of winter and frequent rains ; hence the numerous rivers and canals.

In the formation of these floating gardens of Kashmir, their owners avail themselves of the thick growth of grasses and aquatic plants which spring up from the bottom of the lakes, as water lilies, confervæ, sedges, reeds, &c., all intertwined and entangled one with another. Avenues are cut amongst these by the boats, separating them into angular sections of varying lengths and breadths. The plants and grasses are then cut away from their roots at a depth of about two feet under the water. When so detached they retain their solidity, and are pressed somewhat more closely together. Sedges, twigs, reeds, and roots are next placed over the patch lengthways, and over these mud is spread, fished up from the bottom of the river. This gradually permeates and binds together the matted mass of twigs, reeds, and rushes, and when the surface is thus made, willow stakes are driven through it and down into the bed of the lake, so that the floating garden will rise or fall with the rising or sinking water, but will not escape from its place. By means of a long pole thrust amongst the weeds at the bottom of the Dol and twisted round several times in one direction, a quantity of plants are brought up and carried in the boat to the prepared platform, or raft, where they are twisted into conical hillocks about two feet in circumference at the base and the same high. A hollow place is made on the top of each, and this is filled with the soft river mud, to which is sometimes, but not often, added wood-ashes. These are for the reception of melon and cucumber plants, which are raised for them under mats, and are thus used when they have four leaves. Three of them are planted on the top of each of the hillocks which run in double rows along the sides and ends of the bed, separated with a distance of about two feet between each. Tracts of these beds covering from fifty to sixty acres are thus kept afloat. The depths of the mat of weeds and the soil range from two to three feet, and they are capable of bearing a man's weight. It would be difficult to conceive a more expeditious or economical way of raising cucumbers and melons than this represents, and the success of the growers is extraordinary. Moorcroft, in his "Travels in the Himalayan Provinces," says, "I have never seen in the cucumber and melon grounds of very populous cities in Europe, or in Asia, so large an expanse of plant in a state equally healthy ;" and he adds, "This condition indicated the situation to be congenial to the constitution ofthe cucumber, of which, however, a more substantial proof was found in the very large number of young fruit set near the crown, which certainly exceeded what I have before witnessed in the usual modes of cultivating this vegetable. It has been noticed thai the top of each mound is formed into a cup, or hollow, which is surrounded by a circle or belt of weed. This prevents the male dust from being dissipated, and causes the fecundating process to be as complete as can be wished." The general arrangement is a lme of cucumber cones bordering each edge, and one of water or of musk melons along the middle. The cucumbers are sold, three for a coin of which the value in English money would be about a halfpenny when they are dear, and when cheap the same coin will purchase from ten to twenty. To prevent robbery, the gardens are guarded through the night by watchmen in boats, with the common mat-coverings, under which they sleep by turns. The floating gardens are generally shut in by a belt of floating reeds, which also serve to protect the cones from wind. The boatways through the fences are closed by twisted withes of willow twigs passing from one bed to another.

In the environs, and on the banks of the lake, are the remains of handsome summer palaces and gardens, which belonged to the ancient princes of Mogul, with terraces, cascades, and fountains, fruit and flower gardens, laid out on a symmetrical plan like that of the old French gardens, with alleys, or shady avenues, crossing each other at regular angles in accordance with geometrical designs. Of these famous gardens the most interesting is that of the Emperor Jehanger, which was enclosed by a canal communicating with the lake.

Floating gardens and fields, called Chinampas, also exist in Mexico, where they were originally constructed to afford the inhabitants protection against invaders. They are raised with reeds, bushes, turf, and mud, and were sometimes big and strong enough to support a small dwelling house. These floating garden beds are still to be found anchored upon the waters of the Chalco canal, and, says a modern traveller, "They look right cheerful, surrounded with balsams, and pinks, and border flowers, and planted with plump cabbages, lettuce, and parsnips."

ASTROLOGY.

WHEN men, filled with awe and wonder, began to guess wildly and vaguely at the deeper mysteries of the universe, astrology came into being; when science arose, the chimerical speculations of the star-readers were displaced by clearly-demonstrated facts, and astronomy took its place. But the process of displacement was a slow one, and neither Tycho Brahe nor Kepler, eminent as they were in astronomy, altogether abandoned the fanciful pretensions of ancient astrology. The old Jews and Persians believed that Seth, son of Adam, was the first astrologer, and Josephus says that the Egyptians derived their first knowledge of astrology from Abraham, although the Egyptians themselves trace it to Thoth or Solhus. The astrological emblems of the Chaldean magi, and those of the most ancient nations of whom we have any record—Indian, Chinese, Persian, and Egyptian, together with the Greek and Roman—were the same, bearing the same or nearly the same names, those now in use as emblems of the seasons being Roman. The earliest ideas of which these figures and names were symbolical related to a son of the supreme Deity by a virgin, and a terrible serpent or scorpion whom her son was destined to destroy, and by whom, as was sometimes stated, he was to be wounded in the heel. Each emblem was supposed to have its prophetic bearing on the grand problems of futurity, and in process of time, when the ancient meanings of astrology had grown uncertain and obscure, its professors applied it to the future of individuals, and professed by its aid to foretell all the chief events of other people's lives. Before it became a mere tool in the hands of impostors it had been largely applied to other forms of prophecy, viz., the weather, the coming political events of the new year, and the fortunes of men and women. Its professors had, or were said to have, a systematic form of investigation on which their predictions were based. Thus, in the case of fortune-telling by the stars, or in other words casting any person's horoscope, inquiries were made as to the exact time of birth, to ascertain what sign the sun was in, and the relative positions of the planets.

King Charles I. was a strong believer in astrology, as most persons then were. His favourite astrologer was a famous one (the *Sidrophel* of "Hudibras"), William Lilly, the son of a Leicestershire yeoman, who had been taught the art by another astrologer named Evans. When the king was confined at Hampton Court, and meditating escape, he sent secretly to Lilly desiring him to discover by the stars where the king could be most securely concealed. The King of Sweden also employed Lilly, and on one occasion sent him as an expression of gratitude a very handsome gold chain with a medal struck in his honour.

When the Parliament met in London after the Great Fire, Lilly was ordered to appear before the M.P.'s in the House of Commons to be examined as to his foreknowledge of that awful calamity, in order that the authorities might be the better able to trace it to its origin! He answered as follows:

"May it please your honours,—After the beheading of the late king, considering that in the three subsequent years the Parliament acted nothing which concerned the settlement of the nation in peace; and seeing the generation of the people dissatisfied, the citizens of London discontented, and the soldiery prone to mutiny, I was desirous, according to the best knowledge God had given me, to make inquiry by the art I studied, what might from that time happen unto the parliament and the nation in general. At last, having satisfied myself as well as I could, and perfected my judgment therein, I thought it most convenient to signify my intentions and conceptions thereof, in types, hieroglyphics, &c., without any commentary, that so my judgment might be concealed from the vulgar, and made manifest only to the wise, I herein imitating the examples of many wise philosophers who had done the like." He then goes on to say that these types and hieroglyphics clearly foretold to those who were as wise as he was, first the great plague, and then the great fire, of London.

Hearing how he was so wondrously wise after the event, one of the appointed special committee gravely asked, "Did you foresee the year?" "I did not," answered Lilly, "nor was desirous; of that I made no scrutiny." When asked how the fire originated, the astrologer answered that it was not man's work, but God's. The predictions he referred to were some woodcuts of burning houses, and figures in graveclothes, and graves; but he had figures embellished in like way of most other calamities in the same book, all stated to be enigmatical indications of future events, foretold many hundreds of years in advance!

Astrology either still does, or until lately did, preserve its importance in Persia, where some thirty years ago the Shah had his regularly-appointed Royal Astrologer, without consulting whom no Persian Minister would venture to conclude a political transaction, or even arrange a state ceremonial. The warlike Khans and Begs of Khorasan and Kourdistan never started upon their murderous and plundering expeditions without consulting the planets to discover what time would be most propitious, and even the wandering Pindarri and prowling Thugs were scrupulous in committing their crimes in exact accordance with astrological indications.

In the fifteenth and sixteenth centuries astrology was accepted as truthful by people of all ranks, and was openly and magnificently patronised by the most powerful of European princes, especially in France, where kings, statesmen, courtiers, and even priests, sought its aid regularly, and received its prophecies with profound faith. Both Louis XI. and Catherine de Medici had their private astrologers, and it was in consequence of a prediction of her death that the latter abandoned her new palace, the Tuileries, directly after its completion, the name of the parish in which it stood being astrologically associated with that inevitable event. At the birth of Louis XIV. a celebrated German astrologer was consulted to cast his nativity, the result of which process was solemnly communicated to the Court with formal state. The prediction was briefly given ; it was, "*Diu*, *durè*, *feliciter*," and a medal was struck to commemorate it.

Astrology was a particularly lucrative profession in the days of Shakespeare and Queen Elizabeth, although it was not honoured with such royal patronage as it received in France and other Roman Catholic countries. The most famous astrologers of that time were Drs. Dee, Lamb, and Forman. It had very devout believers amongst the Roundheads who fought with Cromwell, and on one occasion, on the eve of one of the Cromwellian battles, a soldier mounted an eminence and, as the troops filed past, cried out : "So hear what Lilly sayeth. You are in this month promised victory ; fight it out, brave boys, and then read that month's prediction!" Neither history nor tradition tell what Lilly paid for such a magnificent advertisement of his prophetic book.

The learned Elias Ashmole was one of William Lilly's former friends, and it was at his cost that a marble tomb was erected over the astrologer's grave in the chancel of Walton Church.

The chief astrologer at the court of Henry II. of France was a physician named Nostradamus, a native of Provence ; and Charles IX., who consulted him in 1564, made him a councillor of state as well as the royal doctor. His biographer says : "I should be too prolix were I to tell all the honours conferred upon him, and all the great nobles and learned men that arrived at his house from the very ends of the earth, to see and converse with him as if he had been an oracle."

In the fifteenth century an astrologer named Basil, a resident in Florence, was greatly famous all through Italy. It is said he foretold the future greatness of Cosmo di Medici, when he was merely an obscure citizen, ranking him with Augustus Cæsar and the Emperor Charles V.

Kepler, the astronomer, cast nativities, although he sometimes confessed that nothing but mere worthless conjectures could be advanced by such means, and hinted that his necessity but not his will consented when he performed such experiments.

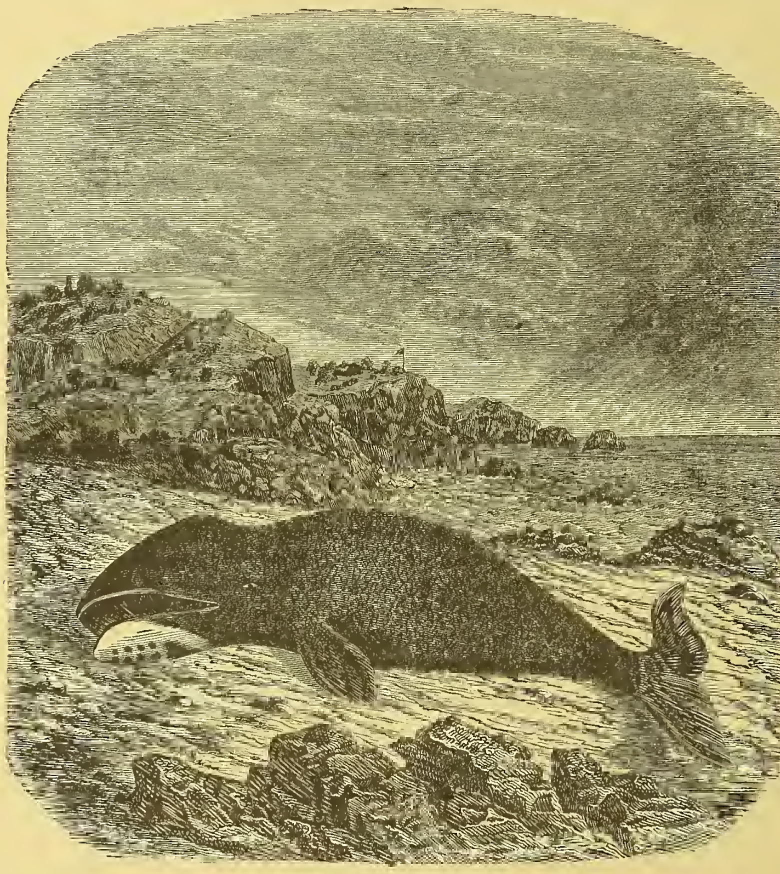
A Roman astrologer of the fifteenth century, named Antiochus Tibertus, employed by Pandolfi di Malatesti, king of Rimini, although he lived in great honour, and acquired wealth, ended his days on the scaffold. It was said of him that long before his end he confessed that the stars foretold that he would die as he did, for the crime of treason ; but this does not appear to have been said of him before the event had taken place.

Up to the beginning of the present century the "science of astrology," as it had been called, still had a large number of believers, as may be seen by referring to advertisements in old newspapers. Some of the newspapers used to publish weekly astrological predictions, and we find as late as 1774 this practice still flourishing in the *London Evening Post*, in a number of which J. Harman, of High Street, St. Giles, foretells the election of Wilkes to the mayoralty of London, on the ground that the planet Saturn was just entering Libra. As a matter of fact the liverymen elected Alderman Bull. In the *Universal Magazine* of February, 1775, it is recorded that an astrologer in Fleet Street, while consulting the stars, had his place robbed by thieves.

The growth of knowledge gradually and surely destroyed this folly and superstition, though it still lingers among the ignorant and credulous here and there. As a modern philosopher (La Place) wrote :—"Equally deceived by the imperfections of his senses and the illusions of his self-love, man long considered himself to be the centre of the movement of the stars. And his vanity has been punished by the terrors to which they have given rise. At length ages of labour removed the veil which concealed the system of the world from him. He then found himself placed on the surface of a planet so small as to be scarcely perceptible in that solar system which itself is but a point in the infinity of space. The sublime results to which his discoveries have conducted him are fit to console him for the rank which they assign to the earth. Therefore we should employ every endeavour to preserve and increase these exalted sources of knowledge, the delight of all thinking beings. They have rendered important services to navigation and geography ; but the greatest of all benefits which they have conferred upon society must be found in the removal of the fears excited by celestial phenomena, and the confutation of error created by our ignorance of the true relations which we bear to Nature."

WHALES.

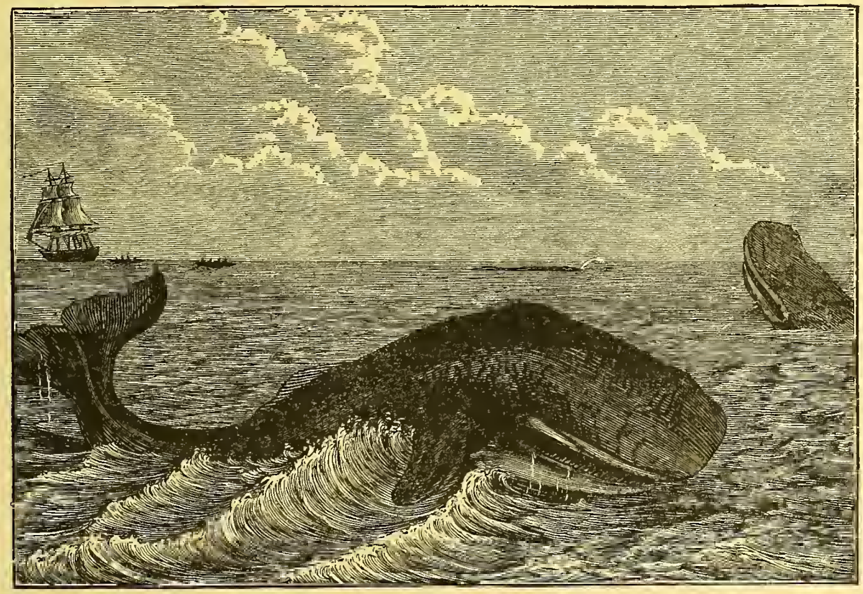
Any one having but a superficial knowledge of zoology, if asked to describe a whale, would most probably say that it was a very large fish ; and if the correctness of his opinion were called in question, he might refer his inquirer to "Johnson's Dictionary," where the creature is similarly defined. This mistake is a not unnatural one. The creature has all the appearance of a fish, and is never seen out of the water, unless by some accident its body is stranded on the shore ; but a few considerations will teach us why this giant of the seas should be classed among the Mammalia, and form a part of the large sub-kingdom to which we as human beings also belong. To begin with: fishes breathe by gills, obtaining the oxygen for their support from the water; whales, on the other hand, breathe by lungs, coming up to the surface of the water periodically for a breath of fresh air, just as we should have to do if similarly circumstanced. A fish is covered with scales ; a whale is not so covered ; and while the blood of the latter is warm, a fish's blood is cold. But the most important difference, and the one which raises the whale to a zoological position far higher than that of a fish, is seen in the fact that the young of the whale is born alive, and is nourished by its mother's milk. Fishes, as a rule, though with some exceptions—that of the stickleback, for instance, as we have seen in a previous article—have not the advantage of parental care. They are hatched and developed from ova, seemingly without attention, and without any defender against their many enemies.



GREENLAND WHALE.

There is another point which identifies the whale with the Mammalia. The heart is double, and therefore capable of receiving and propelling the blood throughout the system. Even in anatomical structure we can find a resemblance to man, and that is in the pectoral fin. In the human arm we find the shoulder-bone, to which is attached the upper arm, then the radius and ulna, and lastly, five fingers. In the whale we have a stunted copy of this arrangement, but the fingers—instead of being so wonderfully gifted as those of man are—are covered with a thick skin, and serve much the same purpose that a balancing-pole does to a tight-rope walker, for the powerful tail is not only a weapon, but the principal organ of locomotion.

The skin of the whale consists of cells filled with fat, and this dense covering serves the animal as a great coat in keeping its body warm in the cold seas which it inhabits. Unfortunately for it, this great coat, or blubber, is valuable as furnishing oil used for burning, for dressing jute, and other purposes; and for this oil the creature is hunted down by its brother mammalian, man. The weight of a well-nourished Greenland whale having a length of 60 feet is, according to Scoresby, seventy tons. Of this vast weight the blubber accounts for thirty tons, the bones ten tons, and the rest of the carcase the remaining thirty. But the right, or whale-bone, whales—which we fear are gradually becoming exterminated by the rapacity of whalers—is a much smaller animal, measuring generally 47 or 48 feet long. But it is very valuable, on account of the high price of the so-called whale-bone, which, in reality, is not bone at all. The bones of the whale are, in fact, almost valueless, unless ground up for manure or put together as museum skeletons. The so-called whale-bone, used chiefly for ladies' dresses, is, in reality, more like hair which has been glued into a compact mass, and it can be separated into what seem to be single hairs by hammering. This baleen, as it is called, serves a very important office in the domestic economy of the whale. It hangs like a dense fringe from the upper jaw of the animal, so that when the creature opens its capacious mouth the orifice is entirely filled with this hairy curtain. When the mouth closes, the plates of baleen lie back, packed away in regular order, until the opening of the mouth causes them once more to spring forward spontaneously (for the creature has no more muscular power to move them than we have to move our teeth), ready for their work. This work is that of a sieve, or perhaps we might rather say a net, in that the baleen is used to catch the prey upon which the monster feeds. One might naturally suppose that such a giant carcase must be nourished by preying upon the larger kinds of fish; but, strange to say, the food of the whale consists of minute creatures, with which the northern seas teem abundantly. At feeding-time the whale will swim lazily along to and fro, with his capacious mouth wide open, to secure as many of these tiny creatures as he can. Then, closing the mouth, the contained water is ejected, leaving the mass of living food caught in the meshes of the baleen, to be afterwards swallowed. As there are generally about 300 slips of whale-bone, or baleen, on each side of the head, it will be readily understood that a thicket is formed capable of securing very minute creatures. The whale-bone whale has no teeth, nor does he require any, for his capacious tongue is quite capable of rubbing to a pulp any food which comes in his way. So we find that old Aristotle was partly correct when he said that "the whale has hairs in his mouth like the hairs of a pig."

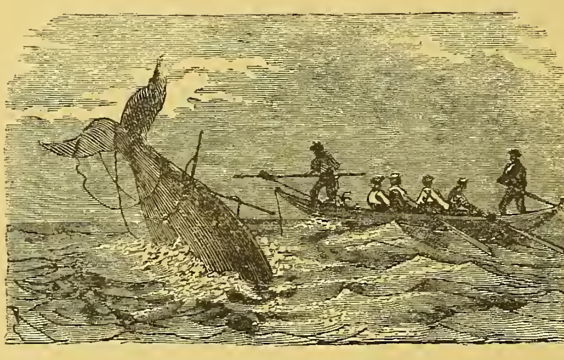


THE SPERM WHALE.

The whale has many enemies besides man, who persecute him to the utmost of their power. It often falls a prey to the sword-fishes, which attack him sometimes in regiments, and although he attempts to ward off their terrible stabs by lashing about him with his powerful tail, they often succeed in killing him. Another enemy is the Greenland shark, who will endeavour to banquet on his huge carcase, living or dead. The saw-fish, with its two-edged weapon, also represents a deadly foe to the poor whale. A parasite (the whale louse) also does its best to make the life of the animal miserable, and the constant gnawing of these pests often covers the skin with horrible sores. Barnacles and seaweed attach themselves to the living carcase as they will to a floating log of wood. So we may conclude that the life of this monarch of the deep is not altogether an enviable one.

Another species of whale is known as the Great Northern Rorqual, which, although often greater in length than the Greenland variety, is not so bulky. Occasionally these monsters have been stranded on the coasts of North Britain ; and such an event occurred not many years ago in the Island of Lewis, West Coast of Scotland. This whale is reported to have measured 105 feet in length, but there was some difficulty in verifying the statement, for the inhabitants of the island quickly did their best to hack the carcase to pieces, in order to secure the more valuable parts. This species of whale is not nearly so valuable as the right whale ; the baleen is very much shorter, and of a coarser kind : it is, in short, adapted for a different kind of prey. Herrings and mackerel form its chief food, and the Scotch fishermen are rather inclined to protect than to pursue it, because it shows them by its blowing where to cast their nets with certainty of success.

In the southern hemisphere are found the whales known as hump-backs and fin-backs, neither of which are considered valuable. But besides these, there is the spermaceti whale, which is hunted as industriously as those in northern seas. The spermaceti, or "sperm" whale, is outwardly distinguished by its enormous head—equal to one-third the entire bulk of the animal—from which the spermaceti is taken ; being in fact known as "head-matter" in the early days of whaling. The sperm whale is considered more savage than the Greenland whale.



HARPOONED WHALE "SOUNDING."

The perils of whale-hunting and the methods by which the creature is killed are almost too well-known to require anything but brief notice here. Suffice it to say that as soon as a whale is sighted, the ship's boats are launched, and approach their prey as noiselessly as possible. The harpoon is thrown—sometimes fired from a gun—and directly the monster feels its stab, it either dives or rushes off at tremendous speed, until forced once more to come to the surface of the water for air. This moment is looked for as the opportunity for planting another weapon in the creature's carcase. Gradually his movements become more and more languid as exhaustion comes upon him, until at last he dies. The carcase is then lashed to the side of the vessel, the blubber and baleen are removed, and the rest cast away to form the food of the many denizens of the ocean. Formerly harpoons were always thrown, there being no difficulty in approaching the whales ; but long persecution has so thinned their ranks, and made them so shy, that the gun harpoon has now become not only general, but almost a necessity of the whale fishery. As the harpoon can thus be launched from a much greater distance, the boat's crew are also much less likely than formerly to fall victims to the sudden attacks of the wounded and infuriated animal. Even with the aid of gunpowder, however, it seems strange that so vast a creature should be so easily slain.

A method of whale-killing peculiar to the fjords of Norway may not be familiar to our readers. When a whale finds its way through the narrow inlet of one of these fjords, he often fails to recognise the passage again. The inhabitants are all on the alert to compass his destruction, and this they manage without the smallest risk to themselves. They shoot an arrow high in the air, so that when it descends it will—if aimed well—bury itself in the back of the whale. The arrow is a short piece of iron, and the older and rustier it is the better it fulfils its purpose. The iron works itself down in the flesh to some vital part, or makes a poisoned wound that soon brings the whale to the surface dead. A loose wooden shaft is fastened to the iron dart, and marks on this shaft indicate to whom it belongs ; therefore no dispute can arise as to the dealer of the fatal blow.

THE TELEPHONE.

Of the many wonderful scientific discoveries and inventions which have made the nineteenth century remarkable, certainly none is of more popular interest than the simple little piece of apparatus known as Bell's articulating telephone. By this instrument it becomes possible to transmit ideas between far-distant places, not in the form of signs afterwards to be deciphered, but as actual articulations, an echo of those produced by the human voice at the point of transmission. Hitherto the common speaking-tube was the only means by which this end could be accomplished, and it is still of great service as a means of communication between different rooms in the same, or adjacent houses. But its range is limited to a fraction of a mile. By the telephone, on the other hand, people have been able to speak to one another although separated by a distance of one thousand miles. This distance at present represents the longest telephone circuit yet established, namely, that between Chicago and New York.

The word "telephone" was first applied by Reiss of Germany, in 1852, to a piece of apparatus contrived by him, by which he was able to transmit musical sounds, and, to a very limited extent, the articulations of the human voice, but the words transmitted were not distinguishable by the receiver unless he was prepared with a list of them, or had been previously told what they would be. Like all other telephones, this—the father of them—consisted of two distinct parts, a transmitter and a receiver. The transmitter was, in the first constructed instrument, of a primitive kind, for it consisted of a hollowed-out bung, closed in at one end with a membrane (a piece of German-sausage skin). In the centre of this membrane, and attached to it with sealing-wax, was a strip of platinum, so arranged that when the skin was thrown into vibration—that is to say, when it was made to move up and down—the platinum touched a wire, so as to open and close a battery circuit. Now a membrane of the kind described, stretched over an opening like a tambourine, has the property of vibrating in unison with any musical note sounded near it. Thus, supposing we sing to such a membrane a note having 250 vibrations per second, the membrane will immediately vibrate in sympathy, and such vibrations will cause 250 battery contacts in a second. Next let us briefly describe the receiving instrument. In 1837 an American physicist, Page, discovered that whenever an electro-magnet was magnetised, or de-magnetised, it gave a little creak or click, perfectly audible and unmistakable. Reiss took advantage of this magnetic click in the construction of his receiver, which consisted of a knitting-needle surrounded by a coil of insulated wire. By this means, every time the battery circuit was opened or closed by the vibrating membrane at the transmitting station, the knitting-needle (or electro-magnet, which in reality it was) was caused to click in sympathy. Now the difference between a mere noise and a musical note, although apparently very wide, is not so theoretically. A tap, a beat, or a click, if sounded separately, is called a noise; but if such noises be caused to be rapidly repeated many times in a second, a musical note is the result. In Reiss's knitting-needle receiver, the clicks, as we have seen, were bound to follow one another at a speed in sympathy with the vibrations of the membrane at the transmitting end of the line wire; and as these vibrations agreed with those of the note sounded into the instrument, that note was reproduced by the receiver. Such was Reiss's instrument, which must be placed in the category of *tone* telephones, to distinguish it from the far more important articulating telephone.

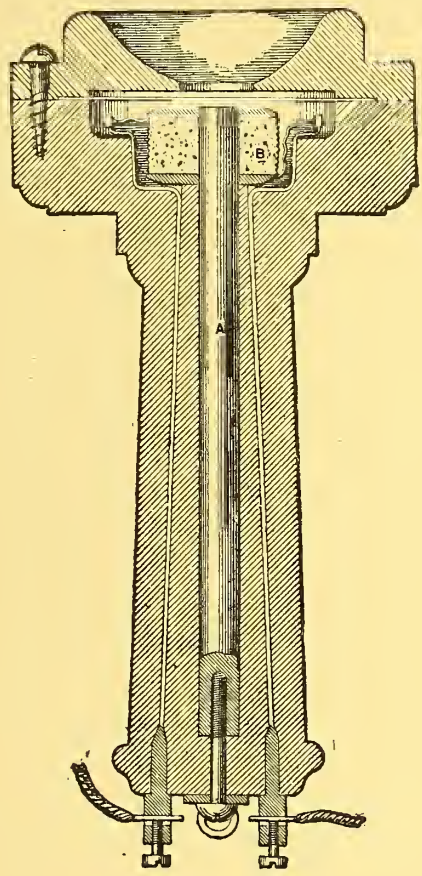


Fig. 1.—BELL'S TELEPHONE.

In Professor Graham Bell's articulating telephone we have a much more wonderful instrument. The receiver and transmitter are identical, the operator placing the instrument to his mouth or his ear, as the case may be. In actual practice it has been found an advantage to employ another form of transmitter so as to gain increased power; but the Bell receiver still holds its own and is likely to do so. In form it has been compared to the handle of a skipping-rope, and it is certainly not unlike one. A wooden or ebonite case contains within it a bar magnet, A, about five inches in length (Fig. 1.) One pole of this magnet is surrounded by a coil of very fine silk-covered copper wire, B, the ends of which are carried to the posterior end of the instrument for easy connection with the line wire. In front of the coil, and as close as possible to the end of the magnet, is fixed a very thin iron plate, or diaphragm; and in front of this again is screwed the mouth-piece of the instrument. This constitutes the whole of Bell's celebrated telephone.

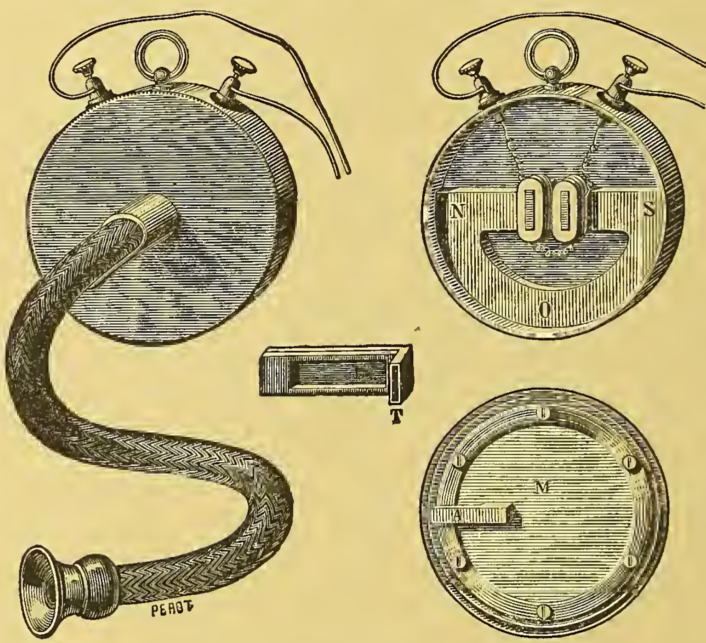


Fig. 2.—GOWER'S TELEPHONE.

We have already seen, in Reiss's transmitter, that a membrane will vibrate in unison with any particular sound submitted to it. The iron plate, or diaphragm, in Bell's telephone, acts in much the same manner. It is true that is not arranged so as to make and break a battery circuit, yet its movements have a great influence upon the current which is generated in the coil-wire by its magnetic core. As it vibrates it is of course alternately brought near to and away from the magnet, and these movements cause undulatory currents to traverse the wires leading to the corresponding instrument, it may be many miles away. There the currents set up influence the iron diaphragm to give exactly the same movements as that of the transmitting instrument, and the original speech is reproduced.

It may at first seem difficult to understand how a vibrating membrane or diaphragm can be made to reproduce speech in this way. Experimentally it can be shown by means of a little contrivance known as the thread telephone, which is simplicity itself, and requires no electric current. Take two large pill-boxes and remove their ends, stretching over the openings thus formed a piece of bladder, one for each box. To the centres of these diaphragms fasten a piece of thread twenty or thirty yards in length, so that you have a kind of tambourine arrangement at each end of a long line. Two persons can converse with the greatest ease by means of this contrivance, each holding his little box, and taking care that the thread is kept tight between the two. In this simple form of telephone, the vibrations of the air caused by the speaker's voice are taken up by the membrane, and the communicating thread causes the distant membrane to be pulled into the same movements. How complicated these movements are has already been shown in the article entitled "Sound in Colours," p. 112. These movements affect the air, and the original sound is reproduced. Instead of the thread, Graham Bell obtains an even better result by varying the strength of a current of electricity, this being brought about by the to and fro motion of the iron disc in front of the magnet.

Gower's telephone (shown in Fig. 2) is on the same principle as Bell's, although in outward appearance it is entirely different. Its power is very much greater, owing to the employment of a very much stronger magnet. In the annexed cut the complete instrument is shown on the left-hand side, with the tube attached, which serves for signalling, speaking and listening, as required. On the right-hand side we have a dissected view of the telephone. The magnet O is in form like the letter D, its two poles, N and S, being brought close together, turned upwards, and each surrounded by a coil of wire. The diaphragm (M) forms the lid of the instrument, and the attached piece marked A (shown larger at T) is a harmonium reed. By blowing down the tube of the instrument this reed is made to sound a signal, which is easily heard some yards away from the receiving instrument. Attention is thus attracted when communication is desired; but in most forms of telephone the ordinary electric bell, placed on the same line wire, is found to be the most efficient call.

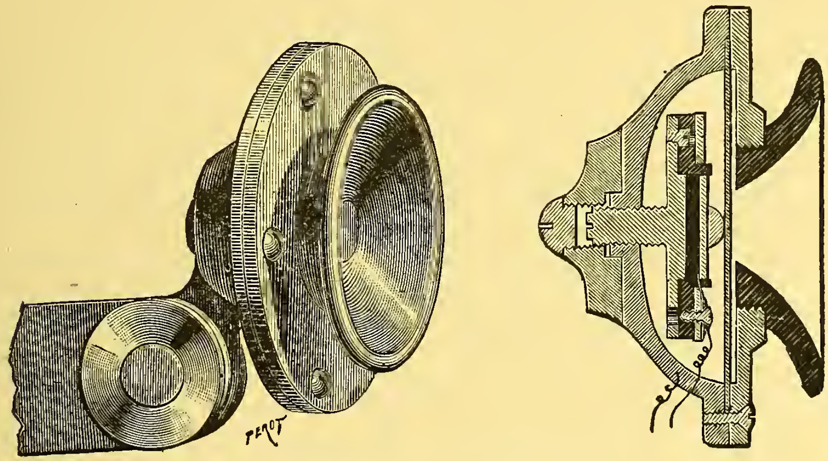


Fig. 3.—EDISON'S CARBON TRANSMITTER.

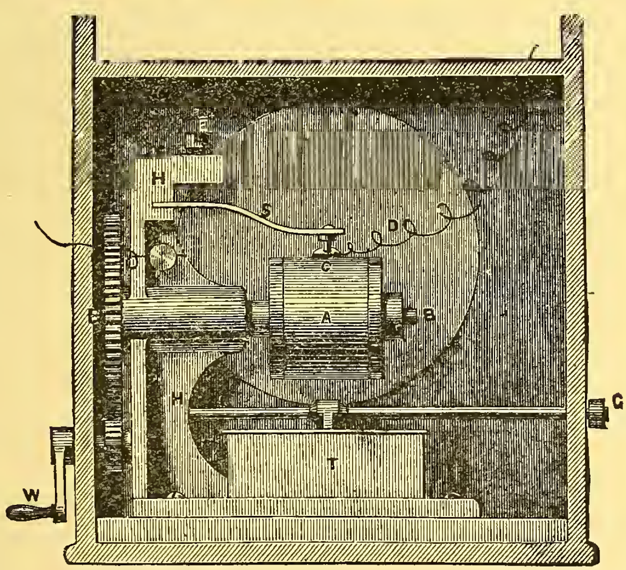


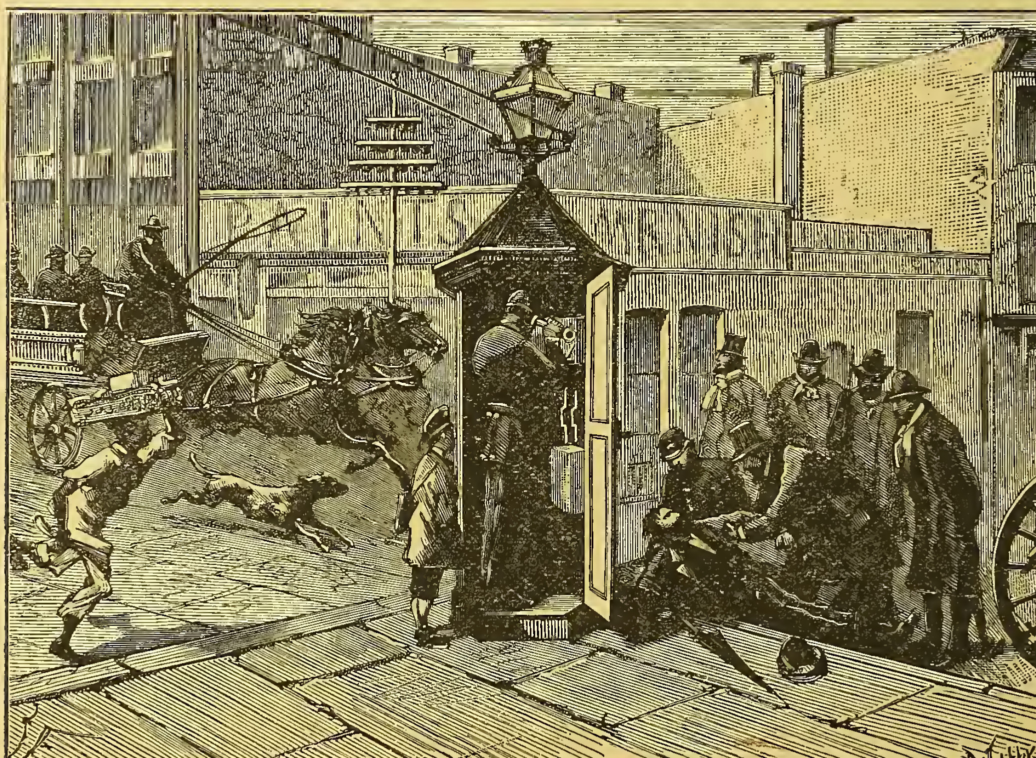
Fig. 4.—EDISON'S LOUD-SPEAKING TELEPHONE.

In Edison's Carbon transmitter, which, by the way, acts most efficiently with Bell's receiver, we have an entirely different arrangement. The instrument is shown in elevation and section in Fig. 3. Within an ebonite ring is contained a little disc of compressed lamp-black, one side being attached by a screw to the metallic frame of the instrument, and the other side covered with platinum foil. On this foil rests a plate of glass, to which is cemented a round knob of metal. On reference to the section this knob will be noticed lightly touching the iron diaphragm, which is placed at the mouth of the instrument. The resistance of the carbon disc varies with the pressure applied to it by the vibrating diaphragm, and corresponding vibrations are set up in the Bell receiver if one be used.

Edison has also invented a very novel form of receiver, which, under the name of the "loud-speaking telephone," caused much sensation when first introduced, though not adapted for practical use. To understand the action of the instrument it will be necessary to describe a simple experiment. A metal plate is connected with one pole of a battery, the other pole being fastened to a strip of flat brass about three inches long and half an inch wide. Upon the plate is laid a piece of blotting-paper damped with a solution of caustic potash. When the brass slip is dragged with some pressure across the surface of the wet paper, it naturally meets with some frictional resistance; but, strange to say, directly the current is allowed to flow through the slip all apparent friction ceases, and the piece of metal glides over the paper as over a sheet of ice. So much for the discovery; now let us see its clever application in Edison's "loud-speaking telephone."

In Fig. 4 we have the most essential parts of the instrument. A cylinder of hardened chalk (A), in connection with one pole of a battery, is moistened with the caustic potash. (This chalk so far resembles the blotting-paper in the above experiment.) Resting upon it, and pressed down by a spring is a slip of metal (C), the other end of which is connected with a diaphragm made of mica (D). When the undulatory current, caused by a speaker's voice at the distant station, reaches the chalk cylinder, which is kept in rotation, the metallic piece (C) is kept continually slipping on the chalk, and so throwing the attached diaphragm into vibration. Well may this instrument be called "loud-speaking," for under the best conditions it can be made literally to shout. We once had the opportunity of hearing its performance before an audience of 2,000 people, the speaker being distant half a mile. Songs, speeches, a cornet solo, were all rendered as loudly as if the performers had been in the same hall. Unfortunately, the chalk cylinder is easily affected by changes of weather, and although it was attempted to render the instrument commercially available, such efforts were speedily abandoned. There are various transmitters at present in use, but the original Bell Telephone, as we indicated before, is still the best of all receivers.

Although the telephone system is making good progress in England, it is far more largely used in America. Our last illustration represents its extended application in the streets of Chicago, where street accidents or fires are readily announced by its aid, street stations like that represented being liberally provided for communication with the central and branch police offices.



STREET TELEPHONE STATION IN CHICAGO.

CATACOMBS.

THE various labyrinths, known as Catacombs, have originated in different ways. Those in Paris, for instance, were originally quarries, from which the material for building the city itself was taken. The excavations thus made were afterwards enlarged, fanciful underground tunnels being dug out, which naturally enough suggested themselves as suitable places of interment for the dead. A somewhat similar origin is attributed to the well-known Catacombs at Rome, and others much less pretentious in extent. Those in Egypt, which are reckoned by far the most extraordinary, are supposed to owe their existence to the strange feelings with which the ancient Egyptians regarded the dead, and which also gave rise to the elaborate process of embalming the corpses of men and the sacred animals.

The most remarkable of the Egyptian Catacombs are those at Thebes, consisting of the Necropolis—a Greek name, signifying "the city of the dead"—and the sepulchres of the ancient kings. These sepulchres are the oldest known Catacombs, and are traceable back 4,000 years. Notwithstanding their great antiquity, however, nearly all of these Catacombs have been rifled of their contents and stripped of their treasures. The mummies also have been abstracted and experimented upon, for the sake of discovering the secrets of the Egyptian art of embalming. An idea of what these Catacombs once were may be gleaned from the following extract, taken from a description by an artist who visited them before they had been completely dismantled:—"I discovered some little chambers, on the wall of which were represented all kinds of arms, such as panoplies, coats of mail, tigers' skins, bows, arrows, quivers, pikes, javelins, sabres, helmets, and whips; in another was a collection of household utensils, such as caskets, chests of drawers, chairs, and beds, all of exquisite forms, and such as might well grace the apartments of modern luxury. . . . . Besides these were represented various smaller articles, such as vases, coffee-pots, ewers with their basins, a tea-pot, and basket. Another chamber was consecrated to agriculture, in which were represented all its various instruments—a sledge similar to those in use at present, a man sowing grain by the side of a canal, from the borders of which the inundation is beginning to retire, a field of corn reaped with a sickle, and fields of rice with men watching them. In a fourth chamber was a figure clothed in white, playing on a richly-ornamented harp with eleven strings."

Next in importance to the Egyptian Catacombs, and possessing, perhaps, more interest for us as the reputed place of worship of the early Christians in times of persecution, and also their final resting-place when dead, are the Catacombs at Rome. The visitor to these Catacombs, provided with wax candles, follows the guide down a rude staircase into a labyrinth of very narrow passages, wide enough to admit only one person at a time. These passages, branching out in various directions, "like the veins in the human body," converge at irregular intervals, and expand into large vaulted chambers resembling churches. Their length was originally twenty miles; at the present day, however, not more than six miles of these tortuous galleries admit of inspection. They are about five feet in width, and from eight to ten feet in height. Along the side walls of the galleries are the niches where the dead were deposited lengthwise, generally in three tiers, one above the other. On the tile that closes the niche is engraven sometimes the name of the deceased, sometimes the letters Xp, which are taken to mean *pro Christo.* In these damp and dreary caverns the bodies of more than 74,000 martyrs are said to have been deposited, amongst the number being reckoned St. Peter himself. Paintings, in a remarkable state of preservation, have been found in them also. Some are evidently Pagan, showing that the Christians did not have exclusive possession; but others contain indubitably Christian emblems. At some places a depth of eighty feet is reached, and so complicated and intertwined are these gloomy passages, that without a guide none who enter could ever find their way back. There is little doubt that more than one rash visitor has thus miserably perished of starvation. At different times these mazes of gloomy passages have furnished inaccessible retreats for gangs of banditti, who have made them their home, or at least their abiding refuge.

The Catacombs of Paris are usually designated the charnel-house, a name that from the usual descriptions of the place seems scarcely strong enough to suggest the horrors that it reveals. It contains the bones of 2,300,000 persons, arranged in a manner so grotesque as to make one stand aghast at the degree of levity or profanity that man seems to be capable of exhibiting. On each side of the visitor, as he advances, torch in hand, through the dismal tunnels, are piled, beginning at the bottom, first "a row of thigh bones, with the large round end outwards, as regularly as a piece of masonry, for about the height of two feet; a row of skulls, with the back part outwards, follows these; next the arm bones, in the same regular manner, for two feet more; and then another row of skulls with the teeth outwards; lastly, on these are placed other bones, arranged as before to the height of six or seven feet." The remains of many of the victims of the great Revolution are here interred; the chief reason, however, for the incredible number of bones is the fact that the churchyards and other burial-places in Paris were, subsequent to the introduction of extramural interment, emptied of their contents, which were removed to these dark abodes. The public are no longer admitted to this chamber of horrors.

Besides the Catacombs noticed, there are others at Naples, Palermo, and Syracuse; in Greece also, and in Asia Minor, in Syria and in Persia; at the old town of Citta Vecchia, in Malta, excavations of a similar kind are made in the rock upon which that town stands. Indeed, so widely distributed are these subterranean cavities, that men seem to have constructed them wherever the nature of the ground was favourable, and they themselves sufficiently advanced to possess the requisite tools.

PROCESSIONAL CATERPILLARS, OR ARMY WORMS.

ARMY WORMS.

PROBABLY the class of insects harbours a greater number of curious forms within its limits than any other group of the animal kingdom. The term "curious" may indeed be held to apply not only to forms of body, but to anomalies in habits, as well as to the marked deviations from a common type, which we may see represented even within a very narrow family circle of the insect group. Of the curious in insect habits, the processional caterpillars, or "army worms," as they are often named, present us with a remarkably interesting example. Every one knows that in the life-history of the butterfly or moth there are represented three distinct stages. From the egg comes forth the caterpillar or *larva.* This, in due time, encloses itself in a cocoon, and becomes the quiescent *pupa* or *chrysalis.* From the cocoon, in turn, the butterfly or moth comes forth, and this in turn, by laying eggs, will inaugurate the life-history just described once more.

Amongst the *Lepidoptera*, or "scale-winged" insects, as the butterflies and moths are named, the *Leucania unipunctata* of North America is included. This moth presents us with an insect-type possessing short front wings, with their outer margin nearly straight. It is of a rusty or greyish-brown colour, with blackish scales, and having its wings spotted with white. From the egg of the moth or *larva* a caterpillar is in due time hatched out. It may be remarked that the caterpillar possesses an entirely different structure from the moth or butterfly. The latter feeds, as is well known, upon the juices of flowers. It drinks up these juices by means of a long tongue or proboscis with which its mouth is furnished, and its digestive system is adapted for the digestion of this liquid food. In the mouth of the caterpillar, on the other hand, we find jaws adapted for cutting and dividing the leaves on which it feeds, and an organisation adapted in turn for the assimilation of this kind of nutriment. The destructive powers of caterpillars, in short, are largely due to the leaf-feeding habits of these forms, and the gardener knows to his cost how quickly and effectually his bushes are stripped of their leaves by the caterpillar's demands for nourishment.

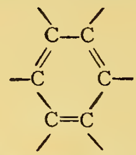
In the case of the *Leucania*, we discover that its caterpillar is somewhat remarkable in respect to its destructive powers. It appears as a smooth cylindrical creature, tapering somewhat to either extremity. The body is striped lengthwise with fine dark lines. In the middle of August the eggs are laid, the moth inhabiting the northern States of America, and its caterpillar being there known as the "army worm," from its processional habits. Developed in great multitudes, the caterpillars set out upon their foraging expeditions. Probably, the habit of hunting for food has been engendered by the immense number of larvæ that are produced, and by the consequent difficulty of obtaining sufficient food near at hand. Be this as it may, myriads of these creatures march in squadrons in search of food. They attack grasses of all kinds, and wheat-fields are ravaged as they march through them. The journeys are chiefly performed by night, the caterpillars hiding themselves by day amidst the grass. Various expedients are resorted to by way of exterminating these insects, or of preventing their inroads. Thus the farmers are accustomed to burn over the grass-lands in autumn. As they march ditches are dug in the line of the procession; whilst fowls and pigs are turned into the fields in August, by way of repressing the insect-invaders whilst they are undergoing their transformation, and with the view of preventing their next year's development.

A curious fact has been observed regarding the "army worm," namely, that it is singularly liable to the attack of other insects. Ichneumon flies deposit their eggs in the caterpillars, which are fed upon by the developing flies. Yet, despite this war which is waged both by man and neighbour insects upon these beings, their increase appears to be well-nigh unlimited.

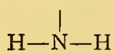
NITRO-GLYCERINE.

IN the article upon "Atoms and Molecules" (p. 333) it will already have been noticed that carbon, especially, of all the elements there mentioned, seemed to have a peculiar power of combining *with itself;* a certain number of atoms being able to coalesce into one molecule, and each additional atom being the basis of a differing compound. Thus we traced the formation of methylic, ethylic, propylic, and other alcohols. In truth, Carbon is a Protean element, capable of thus combining in all sorts of ways; and it is even thought that this property may account for the three widely different forms in which it is found. We know it as a black powder, like powdered charcoal; we know it in hexagonal crystals as *graphite*, or black lead (Fig. 1); we know it in clear octahedral crystals as *diamond* (Fig. 2). All these when pure are pure carbon; yet they have entirely different properties in other respects than in their outward form, and chemists believe this is because the atoms are differently grouped or bound together. Did space permit, it would be interesting to follow out one particular combination of *six* carbon atoms, which Kekulé believes to be arranged in the following way:*

* It is not meant that the atoms are arranged in a hexagonal *form;* but that they are believed to be linked in a chain, so that each carbon atom is bound *to carbon* by three of its four bonds, and has one bond free.



thus leaving one spare bond of each atom free for the attachment of other atoms or compound "radicles." We can only say here, that if each of the six spare bonds shown above is satisfied by a hydrogen atom, we obtain *benzol*, a product of coal-tar. If one of these hydrogen atoms be replaced, in the manner now understood, by the radicle *ethyl*,* we get another coal-product, *toluol*; and if we substitute for that ethylic radicle, by the spare bond of the nitrogen, the radicle



we get *aniline*. Now, three of such aniline molecules can be, as it were, further linked together by these single *nitrogen* atoms, one of which is contained in each of them; and by then replacing one or more of the hydrogen atoms in this triple molecule, by different compound radicles, various sal s o *rosaniline* are obtained, now so well known as dyes. In an analogous way are formed the whole immense variety of coal-tar dyes.

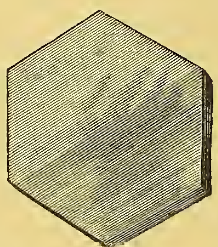


Fig. 1.—GRAPHITE CRYSTAL.

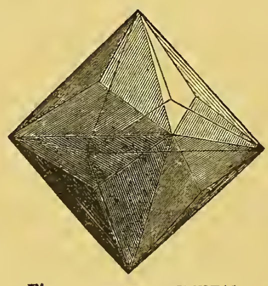
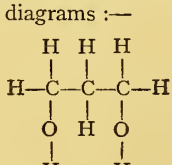
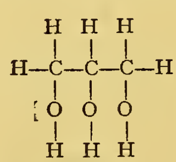


Fig. 2.—DIAMOND CRYSTAL.

But we must go back to our orig nal form of carbon combination. We have seen already how by substituting for one atom of hydrogen in propane the radicle —O—H (hydroxyl) we got propylic *alcohol*. If instead of one only, we do this for *two* of the hydrogen atoms, we get what is called propylic *glycol*. (There are a whole series of glycols, just as of the alcohols and ethers.) The atoms of this may be linked together in several ways; but for the sake of keeping all the subsequent changes at the bottom of the diagram, we will represent the glycol as in the first of the following diagrams :—



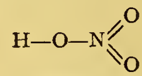
PROPYLIC GLYCOL.



GLYCERINE.

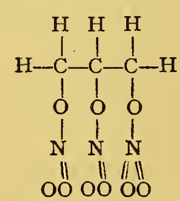
Now by substituting hydroxyl for a third hydrogen atom, as in the second diagram, we obtain the well-known *glycerine*.

Next suppose we treat this glycerine with strong nitric and sulphuric acids, the latter having an intense affinity for water, as we have already seen. Nitric acid is known to have the composition $H N O_3$; that is, a single hydrogen and nitrogen atom combined with three atoms of oxygen; and the structure of the molecule is almost certainly this—



NITRIC ACID.

the nitrogen atom keeping the oxygen atoms apart, and forming, as it were, the centre of the molecule. What now happens? Three of these nitric acid molecules seize upon the three hydroxyl (—O—H) radicles in the glycerine; the atom of hydrogen in each combines with the hydroxyl (—O—H) to form H—O—H, or water, which is absorbed by the sulphuric acid; and the rest of the nitric acid molecules, now converted by the spare bonds into radicles, attach themselves to the rest of the glycerine, by these three spare bonds on each side. The result, therefore, is



NITRO-GLYCERINE.

That this is the structure—the way the atoms are grouped—of this terrible explosive, is almost certain, and we can readily perceive, on reflection, how exactly this structure accounts for the peculiar nature of its explosive effects.

For let us consider very briefly the nature of combustion and explosion. Take, first, combustion. Heat alone does not necessarily mean burning. We can make gold red hot, but it does not burn. Burning is the *combination* of two substances with such intense heat as to give light. Mostly one of the substances is oxygen; and when anything else unites with this, with such heat as to cause light, we say it is burnt up. Many substances that usually unite only slowly with oxygen, with con-

* The terms radicle, ethyl, and other technical words not explained here have been made clear in the previous article.

sequently little heat, will really "burn" if we supply more oxygen. The red-hot tip of an iron wire will really "burn" in pure oxygen gas; and iron in impalpable powder will take fire of itself in the open air; even filings "burn," so as to make brilliant sparks, if shaken through flame. Thus we see how merely to diminish the *size* of the combustible particles, and supply more air to them, makes them burn much faster; but still the iron filings, however diffused through the air, would never "explode." On the other hand, we have seen in the article upon "Dust Explosions" (p. 203) that carbonaceous dust of any kind, if sufficiently fine and diffused, will explode. What is the difference? Chiefly that when carbon burns up, the product is a *gas* called carbonic acid, which takes up while hot a great deal of room; while the product of the burnt iron is a solid—mere iron rust. Explosion, then, is a very quick burning which results in *gas*, expanded by the heat, or otherwise, so rapidly that the air cannot get out of the way. So it is that lycopodium powder, properly diffused in air, goes off with a roar, almost like an explosion; while finer dust actually explodes.

But there is a further difference yet. Make a little heap on a stone or metal plate of iron filings, lycopodium powder, and loose gunpowder, and apply a lighted match to each. The iron will not burn at all, and we need not further discuss that. The lycopodium or dust will, with care, take fire and burn slowly like a bit of wood. The gunpowder blazes up in one brief flash, and is gone. Now, why is this? We know why the dust did not go off; it was not diffused in the air. But neither was the gunpowder—why did that go off? The whole explanation lies in the saltpetre, which contains an enormous quantity of oxygen gas, easily set free by heat. Each particle of ignited charcoal and sulphur in the powder, finds close to it particles of saltpetre, which supply it with all the oxygen it requires. Thus each burning particle of gunpowder, in burning, *finds its own oxygen* in neighbouring particles, and so the powder can explode, without any air at all, in the chamber of a gun. That is why its explosion is so much more sudden; and it is also more violent, because every atom (except for impurities) is converted into hot gas, three hundred times more bulky than the solid powder. We can easily see why, as explained in the article upon "Our Great Guns" (p. 137) powder compressed into solid cubes explodes, or burns, so much more slowly,—the particles take longer to fly off, and leave room for the heat to get to the next layer or particle of the saltpetre.

And now consider our molecule of Nitro-Glycerine. The lycopodium had to get oxygen from the air. The powder got it more quickly, because near every particle of carbon, as fast as ignited by the sulphur, were particles of saltpetre, which supplied oxygen. Each particle here, however, must be really a mass of many molecules. But in the Nitro-Glycerine molecule we see all the elements of explosion inconceivably close together—as close together as *actual atoms*—in the most ticklish, artificial, and unstable combination possible to conceive. Observe that the composition is $C_3 H_5 N_3O_9$. The three carbon atoms only need six oxygen atoms to burn them; and six hydrogen atoms—one more than there are—would only need the three other oxygen atoms to burn them; and both these substances have the most intense affinity for oxygen. Only get the nitrogen—a gas itself—out of the way, and these violent combustibles would attack each other with all the fierceness of "nascent" or as yet uncombined atoms, and all burn up into gas. But the oxygen is divided, and kept away from the hydrogen in the most marvellous way by the inert nitrogen atoms. Note again that these nitrogen atoms exhibit here *five* bonds instead of the usual three: two bonds having a strong tendency, probably, to close upon themselves, and all having a strong tendency to close in pairs into nitrogen molecules.* We see at once how ticklish is the state of affairs, and how on the least disturbance of the dangerous equilibrium, the oxygen atoms, now kept apart at one side of the molecule, will fling themselves upon the hydrogen and carbon atoms, and the whole "explodes." Here the oxygen is supplied in actual *atomic* juxtaposition, and hence the inconceivable rapidity of the explosion. In gunpowder the chemical union can only take place in successive layers of particles; in the nitro-glycerine, atom is ready for atom *in the very same molecule*, while the gaseous volume of the products is three times greater than in gunpowder, as well.

We also understand perfectly the different *character* of the explosion in gunpowder and dynamite, which is simply nitro-glycerine combined with fine mineral dust into a paste. If we lay some gunpowder in a hole, or cup, cut in the top of a rock, it may either flash off, or make a slight explosion, but will not split the rock; having time to push aside the air, and finding that task, gradually though quickly done, the easiest to perform. For powder to "explode" powerfully, it must be therefore confined as in a gun, when it propels the bullet; or the blasting-hole must be plugged up. But the nitro-glycerine expands *instantly* into a space three times as great as the powder. Hence, it is actually less work to split the rock than to lift in an instant the surface of air (at 15 lb. per square inch, the pressure of the barometer) surrounding the volume of gas into which it expands. If it were exploded in a gun-barrel, even with no bullet at all, it would burst the gun into minute fragments. Its effects are terrific, but they are

* See pp. 334, 335.

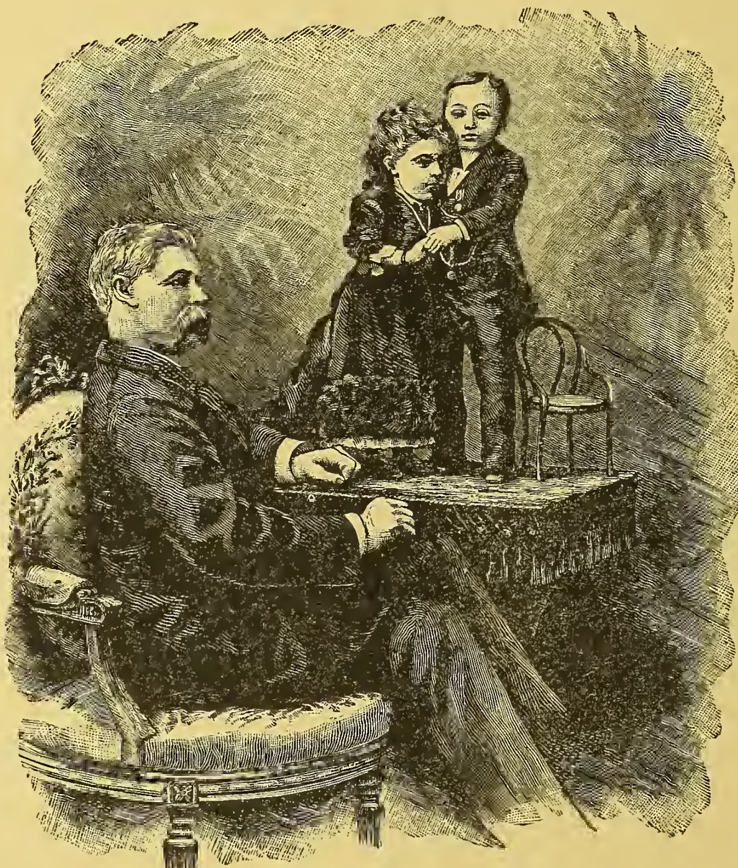
local, because so perfectly instantaneous. And all is due to the curious *separating* effects of the inert atoms of nitrogen, keeping apart violently combustible elements in the same complex molecule.

It seems a strange step from Nitro-Glycerine to Life; but there is a real analogy nevertheless. That Protean element, Carbon, which we have found so interesting, is the basis of all Life on this earth; and is more or less in combination with this same nitrogen, as well as with oxygen and hydrogen. The four form the vast bulk of all living bodies, and the nitrogen in these also seems to play the office of temporarily maintaining combinations which are ever liable to change. But the unfathomable mystery of Vital Force, or Life, whatever it is, does gently and *insensibly* what concussion can only perform with catastrophe in the deadly explosive we have been considering. Imperceptibly the nitrogen is liberated in secretions which give off ammonia; and oxygen and hydrogen combine into water gradually secreted, or evaporated; and the carbon and oxygen combine imperceptibly in breathing; while on the other hand all these elements are taken afresh into the complex organisation, to be re-woven into its substance under the same mysterious control. We have seen the delicacy of the problem. That it should be performed thus gently and insensibly every day, in every living being, is one of the most mavrellous mysteries of our World of Wonders.

THE SMALLEST PEOPLE IN THE WORLD.

On being asked why a certain Miss Davies should be so little and a Mrs. —— so large, Burns wrote the following lines upon a pane of glass in the inn at Moffat:—

> "Ask why God made the gem so small,
> And why so huge the granite?
> Because God meant mankind should set
> That higher value on it."



THE MIDGETS.

This may, perhaps, be a poetically turned compliment, and in that light may be excellent enough, but it can scarcely be accepted as a good and sufficient explanation of the circumstance in question.

It is, however, very odd that whilst the giants as a rule seem to be weak, not over-intelligent, and short-lived, dwarfs are often well-proportioned, vigorous in intellect, and reach a good old age. It is possible that dwarfs receive, owing to their diminutive size, more petting and kindly treatment, while giants have rather been the subjects of fear and awe.

We do not propose here to give any general catalogue of famous giants, or celebrated dwarfs, but merely to describe the two most diminutive people that have ever yet been recorded, and who were, as "The Midgets," exhibited in London in 1882, as well as in almost every other part of the civilised world.

General Mite was then nineteen years old, two-and-twenty inches high, and weighed only nine pounds. A German critic, who saw the Midgets when they held a levee in Frederich Street, Berlin, waxed eloquent upon their pretty looks and elegant proportions. He particularly mentioned the General's liveliness and fondness for jokes, and also approved of the dramatic power with which he sang, in pure and excellent voice, the "Watch on the Rhine," the warlike spirit flashing the while out of his "beautiful little eyes." Miss Millie—who will, we hope, pardon our making public secrets which the sex which she adorns are popularly supposed to be averse from disclosing—was fifteen years old, nineteen inches and a half high, and weighed seven pounds. She is a very neat and pretty little lady, and the General treats her with marked kindness and gallantry, and few things please him more than a polka with her. They share one weakness— a decided *penchant* for chocolate.

The Midgets, like other dwarfs of modern days, recall the Scottish proverb about "Gude gear being little bookit." It will be seen that both of them are considerably less in weight and stature than Tom Thumb, who was twenty-five inches high and weighed twenty-five pounds.

SOME STRANGE WILLS.

AN affluent London merchant, named Peter Isaac Thellusson, died on July 21st, 1797, leaving his estate, and about one hundred thousand pounds, to his widow and children, and the remainder, £600,000, to accumulate in the hands of trustees during the lives of his three sons, and those of their sons and grandsons, with benefit of survivorship. If after a specified time no male issue survived, the whole was to go towards paying the National Debt. This extraordinary will originated two chancery suits, one on a bill brought in by the widow, her sons, daughters, and her daughters' husbands, to invalidate the trusts and substitute a resulting trust for the heir and next-of-kin; and the other on a cross bill by the acting trustees and executors, to substantiate the trusts in the will and dictate the manner of their execution. The property was more than half a million sterling in personalty, and a landed estate of about four thousand per annum. The probable amount of the accumulated fund, it was stated, would be £19,000,000, without considering contingent minorities at the end. Eight objections were advanced. The first and most important was that executory limitations were originally illegal, and only allowed in wills and as trusts in equity, when adopted to enable reasonable and proper provisions to be made; and not allowable when a will was morally vicious, being intended to withhold the enjoyment of property for almost a century, and politically mischievous, inasmuch as it would create a fund producing a revenue greater than the civil list, and rendering it possible for its owner to disturb the whole economy of the kingdom. It was, therefore, asserted that the trusts were such as a court of equity could not execute. The cause was heard in the month of December, 1798, before Lord Chancellor Loughborough, in the Hall of Lincoln's Inn. The devises and limitation were there held to be valid, and directions given accordingly. An appeal against the Chancellor's decree, lodged with the House of Lords, was heard in June, 1805. The unanimous decision of the judges, pronounced by Lord Chief Baron Macdonald, confirmed the decree.

This decision occasioned the passing of an Act restraining the power of devising for accumulation to twenty-one years, dating from the death of the testator.

In 1806 the eldest son of Mr. Peter Thellusson was made Baron Rendlesham. On June 9th, 1859, the question was at last decided, by the death of the last person of the nine during whose lives the accumulations were to continue, and the entire property was divided into moieties.

Another remarkable will was that of Theodore, King of Corsica, whose romantic life and melancholy end has often been described. He died in extreme poverty in 1755, and bequeathed a kingdom, which he had long ceased to possess, to his creditors. It was all he had—or hadn't.

Sir Astley Cooper's will bequeathed his body to the surgeons for anatomical dissection, but the bequest was not, we believe, acted upon.

During the reign of the Emperor Charles V., the will of an attorney who died at Padua left all he had to the nearest relative, on condition that every musician residing in the city, and within ten miles round it, should be present at his funeral; that twelve young women dressed in green were to sing comic songs to the "mourners," and make them laugh, and that while his body was lowered into its grave, the Easter Mass with the Hallelujahs should be sung. Permission to set aside these provisions was applied for, but the judicial authorities decreed in favour of the will, painfully absurd and derogatory as they were.

The will of Thomas Weston, a famous actor, who killed himself with drink, and who had always been deeply in debt and difficulties, bequeathed all the money he had to Garrick, on the ground that he owed him some obligations, and because, as he wrote, "there is nothing on earth he is so fond of, and he will never know when he has enough." Garrick was none the richer for such a bequest, for poor Weston seldom was master of a spare shilling.

The will of the Rev. Sir Richard Stagemore, a rector in Leicestershire, who died in the reign of Charles II., left to his heirs "fifty dogs of various breeds and colours, one hundred pairs of breeches, four hundred pairs of shoes, one hundred pairs of boots, eighty wigs, eighty waggons and carts, thirty wheelbarrows, two hundred spades and shovels, fifty saddles and harnesses, and seventy ploughs.

"*Item.*—A great number of canes and little sticks to walk with, which have been valued at eighty pounds; sixty horses and mares, two hundred pickaxes and pitchforks, seventy-five ladders, and thirty bayonets, swords, and pistols.

"*Item.*—A large waggon full of books in quires, and a little casket in which there is one thousand pounds in cash, and sundry trinkets."

The rev. gentleman's heir proved to be a common London street porter, who came into possession of the above, together with landed estates valued at seven hundred per annum.

A will made in favour of the wife of Dr. Martin Van Butchell, who some sixty or seventy years ago was a well-known eccentric character in the streets of London, was very oddly worded. It entitled her to an annuity so long as her body remained "above ground," and the Doctor, taking this in its literal sense, still claimed it after her death, on the ground that the body of his wife was preserved in a glass case which he kept in his bedroom. After his death the corpse of his wife was interred with his own, and the cash reverted to the heirs-at-law.

A building curiously arranged to resemble the hull of a ship, the rooms of which were made to look like its cabins, used to be pointed out for many years in Wandsworth. Upon the top of it a small room, or rather turret, used to attract special attention, for it contained the corpse of its builder and former owner, an eccentric old sailor, whose will made it a condition of inheritance that his body should be buried on what he called "the deck" of his ship-house. The house was pulled down by a railway company about 1860.

A will, which complained that it had been executed to escape the constant importunities of the testator's wife, was once set aside by the Ecclesiastical Court on the ground that it had been executed under restraint.

In the year 1796 a gentleman died leaving a large library, but, as was supposed, no money, although a memorandum made on the will was to this effect: "Several hundred pounds in Till." The two executors searched in vain for this money, and at last the books were sold and the proceeds devoted to paying the legacies in proportion to the sum realised. Seven weeks after, when the executors were talking of this mysterious memorandum, it suddenly flashed across the mind of one that amongst the books sold were some volumes of Tillotson's sermons, and that one of them might have contained the money. They went at once to the bookseller, asked if he had sold the work, and finding he had not, purchased the volumes and carried them home, where, disposed in several places singly between the leaves, they found bank-notes for various sums amounting to £700. Another very remarkable fact connected with the story is this:—The books had been sent by desire to a gentleman at Cambridge, to whom the bookseller regularly forwarded his catalogues, and, not pleasing him, had been returned.

In an old volume of the *Dublin University Magazine* a curious will is given, which was set aside on the ground that the testator was *non compos mentis*. It ran as follows:—

"Convinced that my dog has been the most faithful of my friends, I declare him the sole executor of this my last will and testament, and to him I trust the disposal of my fortune. I have great cause of complaint against the men: they are of no value, either physical or moral; my lovers are fickle and deceitful; my so-called friends false and perfidious. Of all the creatures that surround me I have found none to possess good qualities but Fidele. I dispose of all my property in his favour; and direct that legacies may be given to all those on whom he voluntarily bestows his caresses, or distinguishes by wagging his tail."

The same authority speaks of the following as a case on record. It related to a gentleman of good family and large fortune, whose sanity no one had ever doubted, and whose habits and ideas had never been regarded as eccentric, save on one occasion, when he purchased the fee of his estate from the Crown, although he had a lease of the lands for 999 years. The manorial rights had never been disputed, and people were naturally astonished and perplexed to know why this was done. However, he was generally so exceedingly prudent and oracularly wise in his actions and speech, that it was set down to some good reason of his own which he chose to keep secret. He possessed a large handsomely-furnished family mansion, and his estate, with the exception of a jointure settled upon his wife, was without incumbrance, and at his own disposal. He had three sons and as many daughters, with whom he lived on affectionate terms. His will neither mentioned, nor in any way provided for, a single member of the family, but ran as follows:—

"I ——————, being in a sound state of mind, and my heart overflowing with universal love and philanthropy, do, in the name of *brotherly love*, and for the promotion of that object, give and bequeath all my property, real and personal, of every kind and description, to the *twenty-eight* persons herein named as trustees, to be by them disposed of in the following manner, that is to say, that they do forthwith sell off all the large beds and bedding in my house of ———, and any articles of furniture which they may consider cumbrous, or not suitable to my design, namely, the promotion of brotherly love. And that they do forthwith re-furnish and re-appoint the said house from top to bottom—always reserving the kitchen and two parlours for refectories—with single beds and bedding most comfortable, and such as pilgrims would desire and deserve, continuing to abide together in brotherly love. I also will that the outer gate of my lawn and the hall-door of my house be perpetually kept open for the reception of pilgrims ; and here I, once for all, declare that there shall be no distinction of rank-made, but that all who come may be admitted, provided they have in their hearts the divine principle of *brotherly love.* And I further direct my within-named trustees to see that there is ever at hand a sufficient stock of provisions, flesh, bread, and vegetables, for the refreshment of all the inmates, together with ale, beer, spirits, and wine (for such as may have need of it), and that there be no stint, but that the pilgrims shall be satisfied to their souls' content," &c. &c.

This wonderfully strange will further provided for the making of a great garden, with lawns and flower-beds, fountains, seats, and arbours, fish-ponds and plantations, for the further delighting of the said "pilgrims" of "brotherly love," and for the building of a yacht in which they might go a-fishing, "like the blessed Apostles," or "take their recreation on the sea," and moreover provided for the employment of "three able-bodied men," who were to occupy a tower he said he had built in Coleraine to "keep watch and ward," armed with muskets and provided with ammunition to be used against all enemies "to the divine principle of brotherly love."

The twenty-eight trustees declining to act, the case was brought before the Lord Chancellor, and in order that this might be legally done, one consented to appear as defendant in Chancery. The case was heard before Sir Anthony Hart, and an issue to try the testator's sanity was directed to the assize town of Carrickfergus. The curious thing was the apparent soundness of the testator's mind up to the date of his death, with the exception of his not considering a tenure of 999 years sufficiently long, and the connection of that fact with a clause in his will stating that its arrangements were intended to last "until the day of judgment." The charge of the judge was against the will, but so feebly so that the jury disagreed, and no verdict was given. However, when the case re-appeared at the next assizes, the verdict of the jury was unanimous, and against the testator's sanity.

In 1863 the newspapers gave currency to the statement that a well-known deceased banker had left a will assigning £3,000 for the erection of a statue to his own memory in Norwood Cemetery.

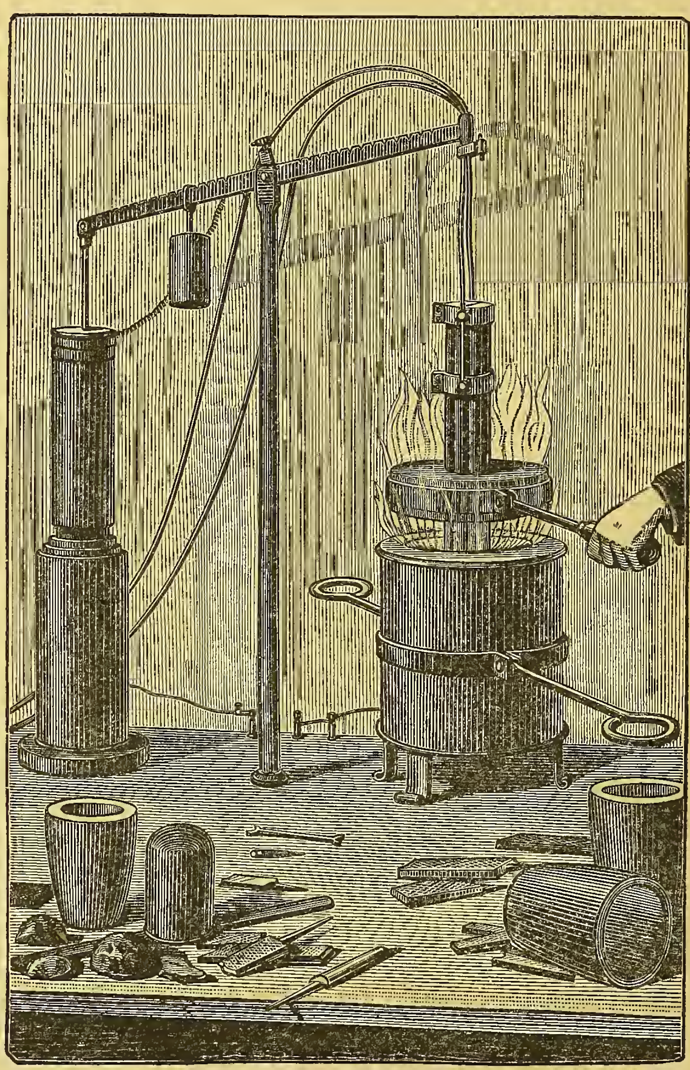
THE HOTTEST FURNACE KNOWN.

WHEN electricity is laid on to our houses and factories, like water and gas is now supplied to us—a state of things promised by sanguine electricians—we shall find many uses for it which neither water nor gas can afford, or can only give us at a prohibitory price. Electric illumination will naturally absorb first attention, but when we are supplied with the current for that, other applications will follow as a matter of course. Some clever people think that our cooking will be also done by electricity, in specially-constructed furnaces. Such a thing may be possible, though hardly probable ; but an electric furnace of another kind has been produced already, and has proved itself to be capable of very wonderful work.

To understand this new application of electricity we must refer once more to those early experiments of Sir Humphry Davy, which led to the discovery of the arc light between two carbon points. In his "Elements of Chemical Philosophy" we find the following words :—"When any substance was introduced into this arch it instantly became ignited. Platinum melted as readily in it as wax in the flame of a common candle ; quartz, the sapphire, magnesia, lime, all entered into fusion ; fragments of diamond, and points of charcoal and plumbago rapidly disappeared, and seemed to evaporate in it, even when the connection was made in a receiver exhausted by the air-pump." Here, then, was a means of producing an intense degree of heat, which, as seen by the concluding words of the quotation, is unlike ordinary combustion in being quite independent of oxygen for its support.

The electric furnace of Dr. C. W. Siemens is simply a modification of this arc light, confined in a non-conducting crucible, as shown in the illustration. On the right-hand side is the crucible, the lid of which the operator is in the act of raising. Through a hole in this lid slides one of the carbon points. The other one—the positive pole—meets it inside the crucible, where it projects through the bottom. The negative electrode, it will be seen, is hung on to a beam, to the other end of which is attached an iron cylinder, which dips into a coil of wire. This arrangement acts as a regulator, by which the distance separating the carbon points is automatically adjusted.

In a paper read before the 1882 meeting of the British Association a great many interesting particulars were given of experiments conducted with this furnace by Dr. Siemens and Professor Huntingdon, of King's College. The intense heat obtained may be imagined when we state that clay crucibles were melted away in a very few minutes. Plumbago stood better than clay, but could not be used for certain experiments, on account of its tendency to affect injuriously some of the metals experimented upon. For these metals particular precautions had to be observed, and they had to be exposed to the heat of the furnace in beds of sand, lime, and retort carbon, representing the most refractory substances which it is possible to obtain. Twelve ounces of copper were fused for half an hour in a bed of carbon dust, with the result that the metal was simply vapourised; it had almost entirely disappeared. Eight pounds of platinum assumed a liquid state in fifteen minutes. In addition to these interesting tests of the power of the furnace there were many important experiments made with a view to determine the amount of carbon which iron is capable of taking up, when a certain quantity of silicon is present. The behaviour of wrought iron when fused and cast in moulds also came under consideration. Many other questions, the answering of which is of great moment to science, it is believed will receive answers under the intense heat of this new furnace.

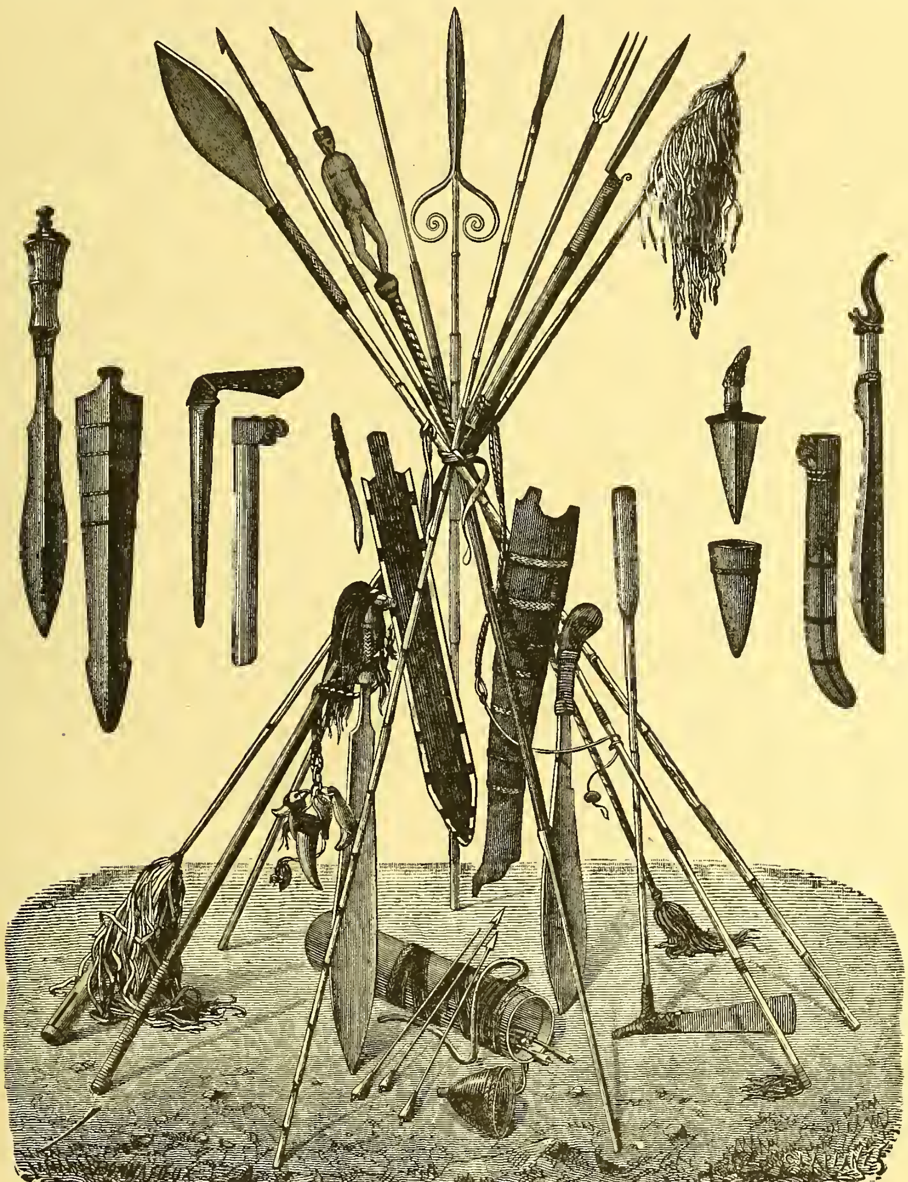


SIEMEN'S ELECTRIC FURNACE.

THE HEAD-HUNTERS OF BORNEO.

THE curious fondness exhibited by the Dyak population of Borneo for human heads, resembles very much the affection of the North American Indian for scalps. They are alike trophies, and alike signs of the possessor's valour. As it is a weakness common to men in every condition of life to wish to be considered brave, it is easy to see how an opinion that judged a man to be courageous according to the number of heads in his possession, no matter how obtained, might lead to the most shocking acts of barbarity. The heads only of enemies were presumably sought; but let a native be suddenly inspired with jealousy of some rival, or with a wish to be famous for his courage, and he would lurk in the jungle, or by the river-banks, dealing out murder upon the unwary man or maid that chanced to come within the reach of his cowardly blows.

The desire for human heads was always present in the mind of the Dyak; upon set occasions, however, and during certain ceremonies, it was absolutely necessary to have heads. Thus, when a young Dyak began to turn his thoughts towards matrimony, he dared not venture to pay his addresses to the object of his admiration until he had captured a number of heads, and thrown them in a net at the maiden's feet. These ghastly symbols of her lover's manhood the lady guarded with great care, and bestowed upon them the unrelaxing attention which the excessive heat of that climate rendered necessary for their preservation. It was necessary not only for the young man who was for the first time entering the hymeneal state to so attest his valour, but also for the widower. All those wishing to marry would form themselves into head-hunting expeditions, and making inroads upon the neighbouring tribes, would cut off indiscriminately the heads of males and females, of young and old. So urgent, in many cases, was the Dyak's desire for a head, that, impatient of the difficulties that stand in the way of getting an enemy's, he would take the head of a friend, and even disinterring the remains of the newly-buried dead, would perpetrate upon them the most disgusting mutilations. No wonder that head-hunting began to be looked upon as a "horrible disease" overspreading that beautiful island.



DYAK WEAPONS.

Another encouragement to slaughter amongst the Dyaks lay in their mode of deciding adverse claims to the same property. Each party that professed to be the rightful owner of the property under dispute had to sally forth in search of a head, and whichever party first succeeded in securing the object of his search, to him was adjudicated the property. No custom could be more inimical to human safety than this. Excited with the passions that mingle with every wrangle over doubtful ownership, fired with resentment towards his adversary, and urged on by the cupidity of a savage beast, the wretched creature would face every peril, and invent the most ingenious stratagems to secure the head that was to establish his right in the eye of the law. Heads were also demanded by the superstitious hopes and fears of these rude tribes. Misfortunes and fortunes alike were recognised and commemorated by heads. A head-house was found in every village, and was regarded with feelings akin to those with which the devotee regards the most valued relic. To increase the grisly stock of these houses was the most noble exhibition of public spirit on the part of the villager; for according as the number of these heads increased or diminished, so did prosperity or adversity attend the tribe. Favourable weather was secured by heads, as were also good crops; by heads women were made fruitful, and marriage unions happy; by the same agency the spirits of the dead were appeased, and the gods made to smile upon all their efforts. A head, in short, was the panacea for every evil, and being so, the demand for heads was insatiable.

With a Kayan tribe of Dyaks a few members of a friendly tribe were staying, and to do honour to their guests, as well as to entertain them, a head-hunting expedition against a hostile tribe was arranged. The party, eager for the fray, set out with all the wild demonstrations of savagedom and the pride of expected success. The warrior pompously assured his mistress that he would return and grace her lap with the heads of the enemy; and the youth not yet privileged to enjoy female society looked forward to a harvest of heads that would enable him to win the favour of the maid for whose love he was secretly pining. These great expectations, however, were not realised; and the party, dejected and ashamed to meet their women without heads, were returning home in silence through the forest. Suddenly a plan suggested itself—they would have heads; so they fell upon their guests, and, forgetting the ties of friendship, swayed only by their affection for heads, they victimised their allies, and exhibited their heads with the same vanity and complacency as if they had been won in a fair encounter with enemies.

After the influence of Sir James Brooke, Rajah of Sarawak, began to be felt amongst these islanders, head-hunting began to decline. The love for heads, however, continued, and was gratified when the chances of not being discovered were sufficiently great. Often would Sir James Brooke be petitioned for permission to take just *one* head. Mr. Spenser Saint John narrates an instance of this kind. Mita was the chief of Siramban—a small village. He had estranged the feelings of his subjects by harsh treatment, and ruined his popularity. Casting about for some means to restore his prestige, he bethought himself that everything would be put right by a fresh head. In petitioning for the right to take this head he was accompanied by the elders of the village, who showed the importance they attached to the matter by joining their entreaties to his, and by the serious expression of their countenances. The permission, of course, was not granted. As Mr. Brooke expressed it, they cried for heads like children for sugar-plums.

The hand of civilisation is at work far and wide, if not ameliorating, at least endeavouring to ameliorate the lot of the degraded and the ignorant. The influence of that hand often appears to many to be of doubtful beneficence. The reason of this doubt is, because most people do not even yet know the awful gloom that surrounds the savage mind.

BLIND JACK OF KNARESBOROUGH.

John Metcalf, the son of labouring people, was born in the year 1717 at Knaresborough, in Yorkshire, and when six years old the small-pox deprived him of sight. As a boy, blind though he was, he became a ringleader in all kinds of mischievous pranks, and knew Knaresborough so well that he could readily find his way to any part of the town. He learnt to ride, and delighted in a gallop, hunted, and when a young man kept hounds of his own; was an expert swimmer, and became famous for the reckless daring with which he undertook to perform dangerous feats. He was a good player at bowls, and, strange to say (as our authorities assert), at cards. He also attended most of the neighbouring race-courses to bet, which he did very successfully. He began to keep horses, and with one of them rode a race on Forest-moor, men being placed with bells to indicate by their sound the course, and where he would have to turn. He was the winner. When in his twenty-first year, his height was six feet one inch and a half, and he was broad in proportion. His great strength and pugilistic skill enforced respect amongst the roughest of his boon companions. After his marriage he purchased a house, and started vehicles for hire; and when rivalry beat him at that, he took his carts and horses down to the coast for fish, which he disposed of at Leeds and Manchester, being generally alone. Finding the profits of this business too small for his increasing family, he took to music, in which he had received lessons as a child, and obtained a situation at Harrogate as violin-player. When the rebellion of 1745 broke out, one of the gentry, Mr. William Thornton, of Thornville, wishing to raise a company of volunteers at his own expense, solicited the assistance of Blind Jack—the name by which he was then well known in most parts of Yorkshire. John, being made sergeant, exerted himself so vigorously that in two days he brought in 144 men, out of which the required sixty-four were selected. Metcalf marched with them, and fought with them, and was at the battle of Culloden, after which he returned to his family. He then began to deal in cotton and worsted goods, buying in Scotland and selling in Yorkshire, and with his pack-horses was soon quite a well-known character on the road. He also did no little business as a smuggler, smuggling being then a crime which people of all classes secretly engaged in or encouraged, and in this, with numerous strange adventures and narrow escapes, he remained many years. In 1751 he started a stage waggon for travellers and goods between York and Knaresborough, driving it himself, twice a week in summer and once in winter. After some time he obtained an engagement in a different line: he contracted for road-making, to qualify himself for which calling he studied mensuration after a plan of his own devising. His first attempt was the making of a road three miles long between Fearnsby and Minskip. To obtain the materials from a suitable gravel-pit, he bought timber and boards, erected a temporary house beside it, with stabling for a dozen horses, and hired lodgings for his labourers at Minskip. He frequently walked in the early morning from Knaresborough to join his men, carrying on his shoulders four or five stones of meal. He completed the work in less than the given time, and to the entire satisfaction of the surveyor and trustees. The feat created a great sensation in the shire; and Dr. Bew, talking with Jack, and expressing his astonishment to him, was answered thus:—

"There's nothing surprising in the matter. You can have recourse to your eye-sight when you want to compare or examine anything; I have my memory to trust to. You have no necessity to keep the ideas of what you can easily see in your mind, so the impressions are quickly obliterated; but I, acquiring my ideas with difficulty, have them so strongly impressed as to be almost indelible."

Dr. Bew says it was astounding to hear with what perfect accuracy he described the course of his road, and the different soils through which it was conducted. When he named a certain boggy portion, Jack said quickly, "Ah! that was the only place I had my doubts about. I was afraid I had been rather too sparing of my materials there."

His next contract was one for building a bridge at Boroughbridge, and this also he carried out satisfactorily. He continued bridge-building and road-making for some years in Yorkshire, Lancashire, Derbyshire, and Cheshire. After some unsuccessful speculations in cotton, he began to deal in hay, measuring the stacks with his arms, and after learning the height, calculating the number of square yards contained in each with unfailing accuracy up to the value of from one to five hundred pounds. In a similar way he occasionally dealt in timber.

He would sometimes act as guide to travellers, who had no knowledge of his blindness, and were astonished and incredulous when told that Jack could not see. On one occasion a stranger asked him whose large house that was to the right, and was promptly answered. When Jack reached a point at which the road was crossed by another going from Wetherby to Boroughbridge, beside the lofty brick wall of Allerton Park, he knew there was a road opposite the park gates. This he turned into without the slightest pause, his only guide the fresh current of air which reached him through the said gates; but bungling a little in opening the gate, turned it off by a jest about the horse he was riding always going to the heel instead of to the head. Presently the gentleman asked what light that was ahead. Jack knowing that a will-o'-the-wisp was often seen near that spot, where there was a patch of low swampy ground to the left of them, asked him which light he meant—the one on the right or that on the left? When the stranger answered that he only saw one, and that was on the right, he was at once told, "Oh! that's Harrogate." They reached Granby in safety, and Metcalf dismounting, took charge of both horses and led them to the stables, being well acquainted with the place. Here he was afterwards found out, for the gentleman offering him a tankard of negus, Jack took it readily enough first, but when it was again offered him was not so successful.

"My guide's been drinking, hasn't he?" said the stranger to the landlord.

"No, sir; what makes you think so?"

"The expression of his eyes—he don't see straight."

"See!" exclaimed the astonished host. "Lor', no, sir; how could he?—he's blind!"

The stranger was for some time incredulous, and thought he was being jested with, until Metcalf, in response to the landlord's appeal, confessed that he was "stone blind."

"Had I known that, I would not have ventured with you for a hundred pounds."

"And I, sir, would not have missed my way for a thousand," said Jack.

Among the numerous roads made by Blind Jack of Knaresborough was part of the Manchester road from Blackmoor to Standish Foot. As it was not marked out, contrary to expectation, the surveyor took it over deep marshes, out of which the trustees concluded it would be necessary to dig in order to reach a solid bottom. Metcalf objected to this plan on the ground of the immense expense and loss of time, urging also other considerations which told against it, arguing the points very ably and urgently with the surveyor and several of the trustees individually. But in vain; they insisted upon its being so done. At their next meeting Metcalf said: "Gentlemen, I propose that I should make the road my own way, and I will undertake, if I am unsuccessful, to afterwards make it again in your way." His contract was to make nine miles of road in ten months. One of the places was peat, and Standish Common was a deep bog over which any kind of road was thought to be impracticable. John set to work in six different places with four hundred men, and where the bog and peat were he cast the work fourteen yards wide, and raised it in a circular form. The water which in many places covered the ground he ran off into the drains. His first great difficulty was found in conveying the loads of stones over the soft ground. To effect this he levelled the end portion, and collecting heather from the common had it bound lightly in small bundles, each about a handful. These he laid in rows, close together, one layer over the other, and having pressed them well in he covered them with stone and gravel. People passing on the way to Huddersfield sneered at his progress, and said dubiously or confidently the work would never be completed. But when in this way he had finished about half a mile public opinion veered round, and the plan was pronounced a complete success.

Dr. Bew said he had frequently seen Blind Jack, with no assistance but that of a long staff, traversing strange roads, ascending precipices, exploring deep valleys, calculating their heights, depths, forms, and situations, in the best manner. His plans and estimates, made in his own particular way, although he was never very successful in explaining them, were nevertheless highly reliable. "Most of the roads over the Peak in Derbyshire," says the Doctor, "have been altered by his direction, particularly those in the vicinity of Buxton, and he is at this time (when the Doctor wrote) constructing a new one betwixt Wilmslow and Congleton, with a view to open a communication to the great London road, without being obliged to pass over the mountains."

Blind Jack died at Stopport, near Wetherby, in the year 1802. His history furnishes a wonderful example of the power of the human intellect, aided by an indomitable will, to overcome infirmities, or to supply the place of bodily organs.

THE RINGS OF SATURN.

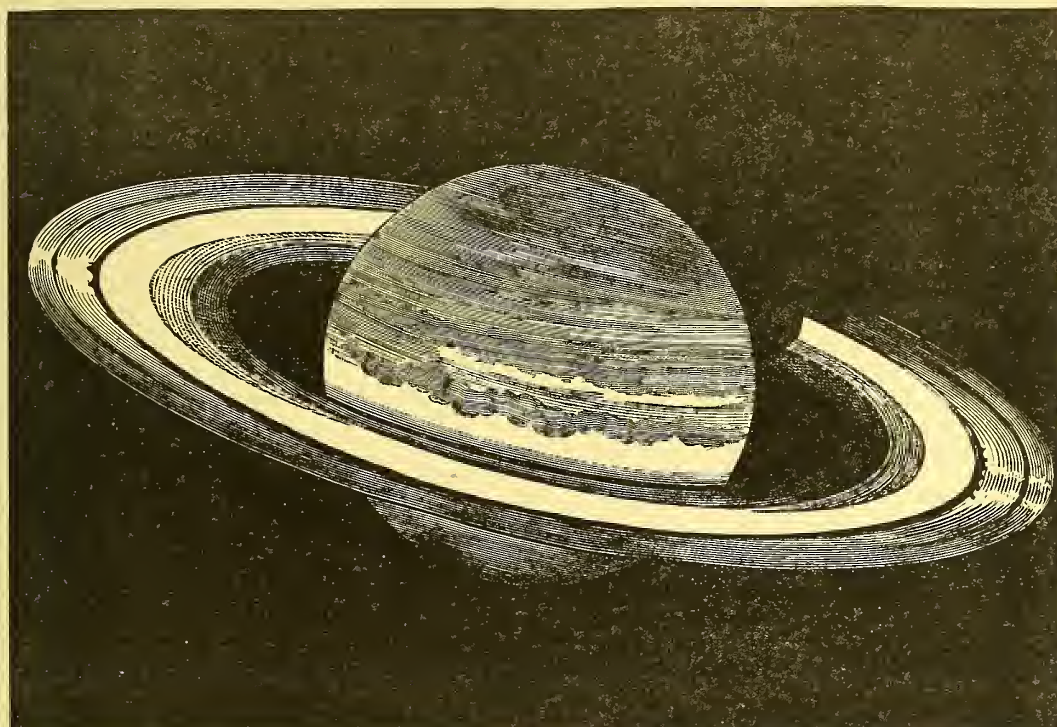
CELESTIAL bodies show a marked similarity of figure in being of spherical form, but one very remarkable instance of departure from the general rule is evident as regards Saturn. This planet displays a globular figure, encompassed round about by a broad flat ring of highly luminous character, which finds no analogy in the case of any other bodies of the solar system. Saturn is therefore an object of peculiar attraction to those who investigate the wonders of astronomy; for his brilliant ring, or rather system of rings, admittedly constitute not only an object of interest, but open up some important questions for discussion. What can have been the origin of this marvellous appendage? Of what is it formed, and what purposes is it meant to fulfil in the economy of Saturn? These are questions which come foremost to the minds of every one who views for the first time this beautiful planet, and discerns, by means of a good telescope, some of the details of structure which the rings present. They form a phenomenon of such exceptional character, of such prominence, and of such attractive effect, that the observer who beholds them can hardly fail to utter an exclamation of surprise and delight, and, afterwards, to ponder much on the mystery of a spectacle absolutely unique in the solar system.

The rings of Saturn being invisible to the naked eye, we know nothing of their history prior to the invention of the telescope in 1610. Galileo failed to see them with sufficient distinctness to enable him to announce their real character, and it was reserved for Huyghens in 1656 to do this. We have no knowledge of any facts concerning the rings before that time. They may ever have been coexistent with the ball of the planet, or have been thrown off at some epoch when Saturn was in a far different state from that we see at present. The exceedingly brief lapse of time during which the rings have been made the subject of telescopic scrutiny has not given evidence of any changes of structure, and it is certain that such changes, if occurring, are spread over vast intervals of time.

Let us consider for a moment the dimensions of these rings. Saturn himself is a large planet, being more than 75,000 miles in diameter. The greatest diameter of the rings is about 170,000 miles, so that it is about $2\frac{1}{3}$ times the diameter of his globe. The rings are entirely separated from the planet by an interval of some 18,000 miles, but covering a portion of this space there is a dusky ring or faintly luminous appearance extending for some thousands of miles from the innermost edge of the bright rings towards the planet, but not nearly reaching it. A small telescope shows merely one bright flat ring, but greater power enables the observer to see that it is really divided into two rings. The black, curving line indicating this division is some 1,700 miles broad, and is well shown in the figure. A much narrower division is suspected in the outermost ring, but this is not always seen, and is probably variable in position. The rings are extremely thin, being estimated at not more than 138 miles in thickness by two eminent observers, though they are fully 64,000 miles in breadth.

The variable position of Saturn relatively to the earth, causes the rings to be presented edgewise to us once in fifteen years, and when this happens their extreme thinness causes them to be invisible. At like periods we are enabled to view the rings when considerably inclined to the earth, and it is then that they are presented under their most favourable aspect.

It must be admitted that these rings of Saturn have offered some curious facts for the theoretical investigation of our *savants*. Their physical constitution has been often discussed, and many efforts made towards a rational explanation of the phenomena. It has also been attempted to show how the equilibrium of the rings is maintained, for unless some special laws prevent such a contingency, they must fall upon the body of the planet. The motions of the rings are doubtless controlled by highly complex though efficient laws, and they represent an elaborate mechanism which is regulated with such extreme nicety that it is enabled to preserve its integrity notwithstanding the precarious conditions under which it exists. The slightest difference of motion between the rings and the ball of the planet must immediately bring about a collision, and once in cohesion, they could never separate, but would thereafter be held together by an immense force. Sir J. Herschel remarks that "their motions in their common orbit round the sun must have either been adjusted by an external power with the minutest precision, or the rings must have been formed about the planet while subject to their common motion, and under the full and free influence of all the acting forces."



SATURN AND HIS RINGS.

As to the composition of the rings we have some curious theories. It is supposed, on the one hand, that they are an aggregation of small satellites extended into a flat ring, but this assumption can hardly be said to recommend itself for adoption. Saturn, we know, is provided with a full complement of ordinary satellites—eight in number—which conform to the analogies of the other planets. Another theory supposes the rings to be formed of streams of fluid flowing around the planet. This, however, has its objections, and it must be admitted that, however well such theories conform with observed facts, we cannot definitely accept either of them as reliable. An hypothesis, though recommended by its probability, and seemingly in close agreement with the prevailing conditions, may nevertheless be utterly erroneous. We cannot do better, therefore, than to look upon such efforts distrustfully, for it would be rash to assume that we have bridged the vast interval of more than 800,000,000 miles separating us from Saturn, and learned the profound mystery of his rings. Whatever this mystery is, it lies hidden at present, for we can only survey it from our far-off standpoint, and guess at the interpretation of so wonderful and stupendous a structure. The imperfect view which—by means of telescopic power —we are enabled to gather of its appearance, gives us a remote idea of its grandeur, but what must its effect be to an inhabitant on the globe of Saturn? From the equator of the planet, the rings will probably span the sky as a brilliant semicircle, while in higher latitudes, they will appear broader, and even more conspicuous. Indeed, with every difference of latitude, the rings will assume a varying aspect, and a vast and gorgeous amount of scenery, of which we can have no adequate conception. Moreover, the eight satellites which attend the planet will add greatly to the beauty and variety of the firmament. The miniature view which our telescopes give of this wonderful planet is full of significance, if we make some effort to conceive its immense size, and the magnificent and elaborate scenery which evidently form its special distinction.

THE MAIN-SPRING OF THE UNIVERSE.

In considering briefly some of the facts known about what we call matter, and about those different forms of it which chemists call "elements," while we have found very many links and relations between these elements, which seem to connect them together by wonderful general laws, so far as we know every element preserves its identity under every possible process. Combine, and recombine, and break up again *ad infinitum*, we always get again the very *same* substance and no other; and we always get, if our processes and measures are accurate, the very same weight of it. Besides this ponderable matter, however, philosophers soon found there were other conspicuous phenomena around them, which were certainly not matter, and could never be weighed, but which were for all that easily recognised, and were very real. The light of the sun; the flash of the lightning; the heat of any body; simple motion itself,—what were these?

Fire at least appeared so real, that the ancient philosophers did reckon it as one of their "elements." That notion gradually gave way before better knowledge, and by degrees these phenomena came to be recognised as Forces of Nature, and were so called. They were also called "imponderables," because evidently not material. A mass of matter when heated, or electrified, or in motion, did not weigh either more or less, by a millionth of a grain. These forces also are so apparently distinct, and so well marked in their effects, that it was thought they were *separate*, distinct Forces, in spite of many observed relations between them. Thus, the sun illuminated a body; and also heated it; and also, if it were a photographic plate (and probably whether it was that or anything else), produced chemical change in it. But it was thought that "light rays" and "heat rays," and "chemical rays," were all bound up together, as it were, in a sort of bundle, in the sunbeam. It was thought each was there independently, almost like the different elements of matter; and such was substantially the opinion until what seems yet a short time ago.

It would take too long to explain how this belief was gradually destroyed by observation and experiment; but the grand impulse towards the truth was undoubtedly given by researches into the effects of heat, by Carnot, Rumford, and others in the early stages, and by Mayer, Joule, Regnault, Tyndall, and others in living memory. Gradually it was discovered that *heat* always did some sort of *work*. Then it was found that whenever *motion* was stopped, or apparently stopped, *heat* was produced; as when a blacksmith makes a rod of cold iron red hot by the suddenly arrested blows of a hammer, or a leaden bullet is melted by its blow upon an iron target. Then it was found that whenever mechanical work was done, heat was *absorbed*, or disappeared, or became latent, or was used up in some way; as when heat is absorbed by a mass of melting ice, without raising the temperature at all till *all* the ice is melted. And finally, Joule proved by the most rigid experiments that a given measure of heat produced an exact and invariable *amount* of work—neither more nor less. Heat sufficient to raise a pound of water one degree in temperature, is sufficient to raise about 772½ lb. one foot high, neither less nor more.

Thus there gradually grew up the clear idea that heat and mechanical work were correlatives, and that either of them could be transformed into the other on certain invariable terms. Both were, therefore, found to be different *forms* of a subtle and mysterious *Energy*, or Power of Doing Work. Rapidly it was discovered that the same was true of all the rest of Nature's mysterious Forces. The Light falling on a body, if at all absorbed, warmed it, or was converted into Heat; the current of a galvanic battery could produce Motion in an engine, or Heat and Light, or chemical action in the electro-plater's trough. Any one form of Energy could be transformed into any other form, by proper means. And finally it was seen that all the Work going on in the universe, all the changes and phenomena around us, were simply due to constant transformation of one or the other form of Energy into some other form.

Take, for instance, one of those dynamo-electric machines described in former pages, and see what its operation represents. Ages ago the energy of the sun separated carbon from the carbonic acid of the atmosphere, and stored it up in beds of coal. The energy of chemical action between this carbon and atmospheric air, under the gas-retort, produced *heat*, and this heat again did *work* in separating gas and other products from other coal in the retort. Chemical union of this gas with air once more transforms the energy into heat again, which is once more transformed into mechanical motion, in a steam or gas engine. That motion is transformed into electric current; and that may be converted into motion again; or may perform chemical work in electro-plating; or be utilised once more as intense heat and light. This is a mere specimen of what is going on everywhere around us; and our very Life itself, in its physical aspects, is an example of the same transformation of Energy. There is much in our lives that is not physical: we know no physical equivalents for consciousness or genius. But as regards the objective phenomena of life, we are true machines. For us also the sun stored up food in plants, and through them in animals; and the food is by vital processes converted into heat, and muscular work, and mental energy or effort.

We soon find there are two kinds of energy. Let us take a heavy pendulum and swing it. When at the middle of its swing, at full speed, it would give anything which came in its way a good hard knock. But if the resistance was enough to stop it, there would be no more motion; it would stop still for ever at the lowest point. That kind of power to do work by actual motion is called *kinetic* or actual energy. Let the pendulum now swing on till it reaches just the highest point; for one moment it has no motion whatever, and would give no knock to anything it barely touched. But it has the *power of swinging back again*, owing to its elevated position. This form of the power to do work is called energy of position, or *potential* energy; because the energy is not in action, as it were, but quietly stored up ready for use.* The two kinds of energy are correlative, as will easily be seen—each diminishes as the other increases; and the amount of the two added together must always be the same. It does not seem so in the pendulum, which stops after a while; but this, as every schoolboy knows, is because part of the work in swinging is expended in friction at the point of suspension, and part in the friction of the air, and part in compressing the air in front of it. If all these fragments of work could be collected, the total result would always be the same.

This brings us to a very important truth indeed, known as the *dissipation* of energy. All the forms of energy may be ranked in series as higher and lower, heat being the lowest; and at every transformation we cannot prevent some of the energy from passing into lower forms, and most of all into heat. The pendulum is meant merely to transform energy of motion into energy of position, and *vice versâ*; but some of the energy *will* transform itself into the heat of friction, and we cannot prevent this. It follows, in reality, from the fact we have already learnt, that heat *is* motion, distributed amongst the particles of matter. It is just as if a large box were studded inside with small balls fixed on elastic stalks; any motion imparted to the box would be partly converted into individual vibrations of the balls. Some of the motion of every whole mass *must* in this way be changed into motion in the parts. Heat also tends to diffusion in the mere using. To get work from heat we must have something *more* hot than something else; and in using the heat, both get more nearly the same. But if everything were equally hot, though the heat would be as real as before, and would still represent actual motion amongst the ultimate particles of matter, we could do no more *work* by means of heat at all; since all would be converted into *equal* motion of the separate particles.* Now in every change, or act of work done, *some* degradation of a part of the energy takes place, either into this actual form of diffused heat, or at least into some other lower form of energy than that which is at work. This loss of the energy actually available for mechanical work cannot be recovered; we cannot recover what is lost in our pendulum, transformed into heat diffused in the atmosphere.

That is the demonstrable process now going on everywhere: the energy, though its amount remains

* Other forms of kinetic and potential energy do not differ from these simplest mechanical forms so much as may at first appear. To force two atoms apart, is as much mechanical motion, or mechanical work, as to split a rock by nitro-glycerine. It requires a vast amount of energy thus to separate combinations of elements. On the other hand, when separated the energy is stored up in them, and can be called into action again by chemical *combination*, which causes intense heat or other effects. As in the case of the pendulum, therefore, here also the difference between actual and potential energy consists essentially in a difference of relative *position* compared with other portions of matter.

* It may appear as if such a state of things denies the then existence of energy, or power to do work, at all. This is not so, however, since the keeping in motion of the particles of matter is as real mechanical work as any other. The difference is simply that each particle of matter having at last obtained, as it were, its own equal share of energy, has no means of acting further upon any other particle. It is simply that the *larger* exhibitions of work come to an end.

the same, is gradually working down into motion equally diffused amongst the ultimate particles of matter; and then, so far as appears, all transformation must come to an end, and no further change can take place. But here we are confronted by a necessary conclusion from the same facts. Things cannot, for the very same reasons, have worked from eternity merely as they are working now. If they had, an eternity ago the great clock must have run down. If purely physical forces, and physical matter, *and nothing else*, had operated as they now are working, for an unlimited time, this must have been the result. As Professor Tait and Sir William Thomson both affirm, the state of science now "enables us distinctly to say that the present order of things has *not* been evolved through infinite past time by the agency of laws now at work, but must have had a distinctive beginning, a state beyond which we are utterly unable to penetrate—a state, in fact, which must have been produced by other than the now visibly acting changes." Further than this, physical science does not presume to affirm.

We find then a great distinction, according to present knowledge, between Matter and Energy. Both appear in many forms. But we cannot change one kind of elemental matter into any other kind, and can always recover exactly the same quantity of it, after all changes. Energy, on the other hand, can as a rule be changed into *any* other form; but we never can get back the same amount of free or available energy in the higher forms; a proportion is always being degraded into lower forms, less available for "work" in the common acceptation of that term. Thus it is that all the planets are cooling, and that the moon has cooled into a frozen and dead world; thus it is that our own bodily lives, stamped with this same imperfection, come to an end.

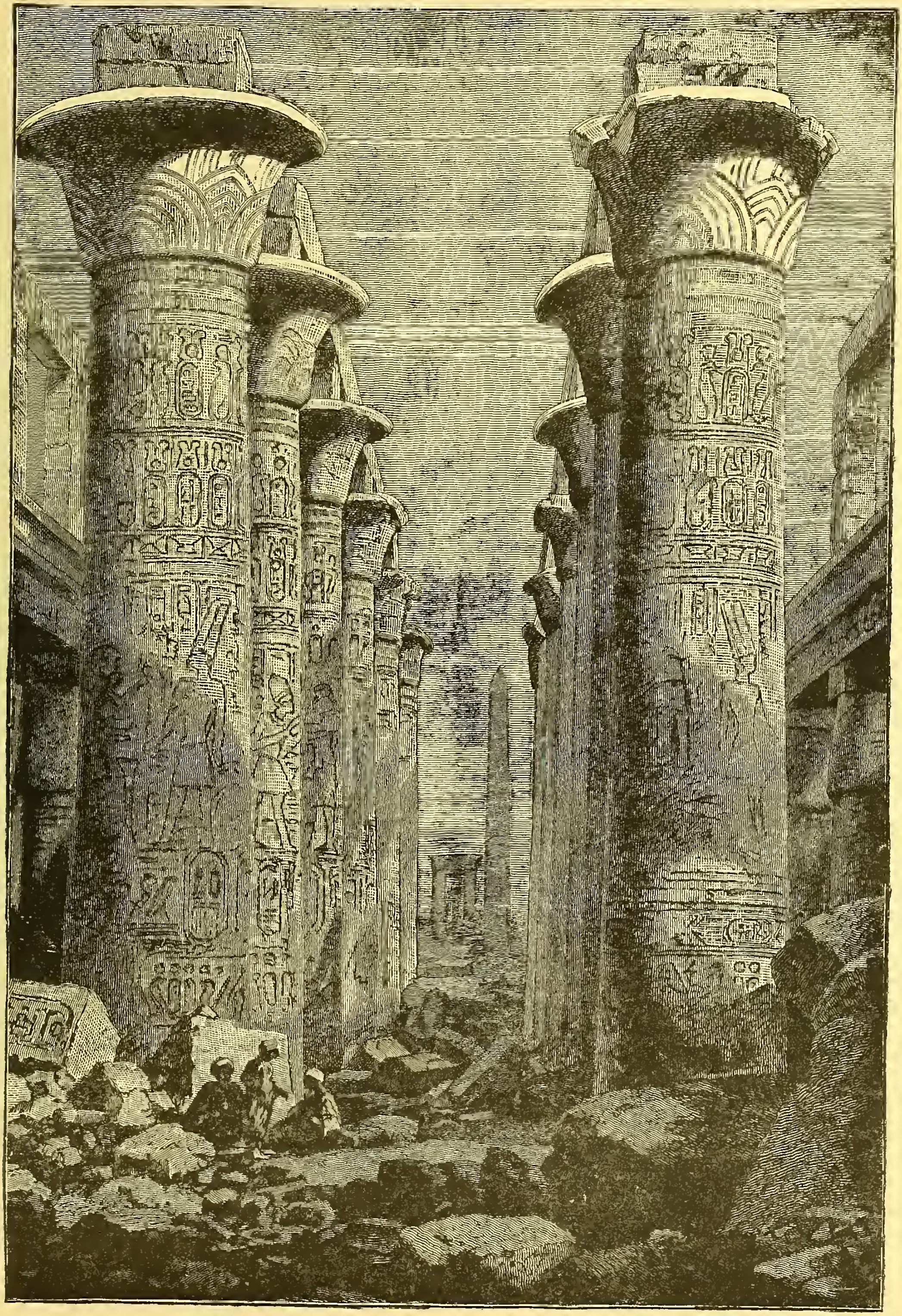
Our remarks on Energy, brief as they are, would not be complete without special reference to one form of it which so far has presented an insoluble problem, viz., Gravitation. Sir Isaac Newton is often said to have discovered the "law" of gravitation: he carefully disclaimed having done any such thing. What he did was to discover and verify the *fact* that every particle of matter *did* attract every other particle of matter with a force varying as the inverse square of the distance. Why it should, or how it does so, was as mysterious to him as to us. That gravitation is a form of the universal Energy it seems impossible to doubt. We owe to it the very energy of position in our pendulum which has been mentioned, and which was capable of being converted into energy of motion. And motion, we have seen, can be converted into any other form of energy; if indeed all these are not themselves mere *forms* of motion, or various states of strain produced by motion, as most scientific men think they are. But gravitation refuses to be brought into relation with any of these other forms. It cannot be reflected, or refracted, or in any way modified; all bodies are absolutely transparent to it; it never can be made to apparently disappear, as can all other forms of Energy. So far as we yet know, it seems to stand by itself alone, unaffected and unaltered by all other operations of the mysterious agency we have been considering. That it *is* linked with them our pendulum teaches us; *how* it is linked with them, has hitherto baffled all hypothesis and experiment. It can only be mentioned here, that many have thought the amazing heat-radiation of our sun and of other suns is kept up by compression, under the self-attraction by gravitation of his enormous mass; and it has been calculated that a compression of one mile in diameter every seven years would be sufficient for the purpose, and would defy detection by the most delicate instruments. This is merely one hypothesis out of several as to the sources of the sun's heat; but if it should be the truth, Gravitation would be the central, primordial form (from the purely physical side) of all the energy in the solar system.

THE WONDERS OF THEBES.

AMONGST the most extraordinary of the world's wonders are those gigantic and magnificent remains of ancient art which arose in their full splendour in Egypt, while Europe was in the gloomiest depths of ignorance and barbarism. They were the pride and glory of a land in which civilisation and refinement reigned supreme, which was most learned, powerful, and flourishing. They are vast indestructible monuments of human power and ambition which overwhelm the mind with wonder, and almost defy the power of description. It is difficult to imagine they are not the works left by a race of giants extinct many ages ago. "Bow down," says an enthusiastic modern traveller, "ye boasted edifices of Greece and Rome, bow down before the temples and palaces of Thebes in Egypt! Its proud ruins are still more striking than your most pompous ornaments, and its gigantic remains more sublime than your monuments in perfect preservation. The glory of the most celebrated fabrics is eclipsed by the prodigies of Egyptian architecture, and to do justice to their grandeur and beauty would require the genius of those by whom they were planned and executed."

Thebes—or, as the Greeks called it, Diospolis Magna, the great city of Jupiter—is the most ancient city in the world. Homer sang of its glories as unrivalled, and called it—

> "The world's great Empress on the Egyptian plain
> That spreads her conquests o'er a thousand states."



THE GREAT HALL OF KARNAK.

It is mentioned in the Bible by the name of No and Ammon No. Tacitus says it was able, upon an emergency, to place on the battle-field an army of 700,000 men. In it was founded the first college and the first king's palace. Its circumference was twenty-three miles. For 3,000 years the sand has accumulated within it, burying some of its largest monuments, and in some instances hiding almost entire temples. Of its foundation we know nothing; and if its remains did not exist, all that we do know of it would be rejected by the incredulous as mere old-world fables.

The observer who first approaches Thebes sees only a confused mass of vast obelisks, portals, and columns towering above palm-trees, but a closer and longer inspection awakens sensations of awe and astonishment, by revealing more fully its many wonders, of which the chief are the Palace-temple of Karnak, the Temple of Luxor, the Memnonium, the tomb of Osymandias, and the mountain tombs. which last have already been referred to in the article upon Catacombs.

Karnak surpasses in its grandeur all the others. It stands at the south-eastern extremity of the city, and its name is derived from the village which has sprung up on a portion of its site. The French engineers, when Napoleon invaded Egypt, were one hour and a half riding round it. The temple itself is 1,200 feet in length and in breadth 420. It is appproached by a long avenue of enormous sphynxes, the largest in existence, and by a succession of gates and colossal statues, constructed of different stones and marbles. It presents an aspect of singular confusion, rendering it difficult to separate its parts; a medley of shattered and broken columns, statues, and obelisks, amongst which some are prostrate, others majestically erect; relics of immense halls, with a forest of columns, portals, and propylea; and in its western end a seemingly endless series of gates, portals, and halls, ranged one after another in a design which was originally one of perfect and harmonious symmetry and beauty. Two of the sculptured obelisks are sixty-nine feet, and one ninety-one feet high. What was the chief hall, 159 feet in breadth and 318 long, has for the support of its roof 134 grand columns; each seventy feet high and eleven in diameter. One long avenue of such pillars has fallen entire, and lies in rows at equal distances apart. All the sculptured work has been coloured, and still retains its brightness. The avenue of sphynxes has now but fifty of its six hundred still standing.

Belzoni asserts that the most sublime ideas which can be formed from the finest and grandest specimens of modern architecture, fall short of that which these ruins convey. The great army of enormous columns, adorned all round with beautiful figures and varied ornament, the lofty portals going far away back into the distance, the vast labyrinth of wonderful edifices: all conspired to isolate him from the present, and elevate his ideas into another and a greater world.

The Temple of Luxor, especially when viewed from the river which flowed through the city, is a sight of supreme loveliness. It stands in a plain covered with palm-trees, with mountains stretching away behind it, contrasting strangely with the wretched huts of a miserable village. Beside its portico stood two obelisks, each nearly eighty feet high, and thirty-two in circumference, composed of a single block of beautiful rose-coloured polished granite from the quarries of Syene,* and two colossal seated statues, partially concealed by the rising sand, each carved from a single block of black granite. The propylon, which is 200 feet high, contains stone enough to build a cathedral. Inside it has 200 columns, varying in dimensions, most of which are entire. All its apartments are covered with sculptured work, executed with extreme care and delicacy, the work being as minute in parts as if it were that of a seal-engraver. Here it is traditionally supposed old Homer studied the sculptured battles and triumphs, and gained inspiration for his most heroic strains.

The Memnonium is undoubtedly the oldest part of the city. The solidity and weight of the masonry, the greater simplicity and irregularity of its design, and the rudeness of its sculpture, all indicate its superior claim to antiquity. In one of the outer courts are the broken fragments of a colossal statue, covering a space sixty feet square, and giving it the appearance of a quarry. This is said to have been the statue of Memnon, which was made from a single block of stone. According to Philostratus, it represented a human being in the bloom of youth, with his face towards the rising sun. When the first beams of the morning sun fell upon it, we are told it emitted sounds, those of the seven vowels, whence language sprung, and these were regarded as symbols of the seven planets, which composed celestial music, and in the dark made melancholy sounds. The breadth of the shoulders of this statue is twenty-five feet; the ear is three feet long. It was overthrown very laboriously by Cambyses, King of Persia, when he ravaged Egypt, and the excavations made for the wedges which were then used are still traceable. At the entrance of the gate are the remains of a smaller, but still colossal, statue, and in the plain adjoining are the hopelessly defaced remains of two other gigantic statues.

Tradition says the statue of Memnon, although broken and overthrown, did not cease to welcome with music the first smile of its beautiful day-god, nor to bemoan its absence during the night. The upper part of this famous statue, now mute enough,

* One is now in Paris.

is, according to some authorities, now in the Egyptian collection of the British Museum.

The tomb of Osymandias was, as the historian Diodorus informs us, at once a palace, a library, and a tomb. It was a mile and a quarter in circumference, and was adorned with sculpture of the greatest excellence and splendour. The vestibule in front of the building was of various coloured stones, 200 feet long and 68 feet high. Adjoining this was a portico 400 feet square, the roof of which was supported by colossal figures of animals, each 27 feet high, and cut from a single block of granite. The ceiling was of marble, blue, and adorned with golden stars. From this you entered a second court, more richly and elaborately adorned in the same style, at the entrance of which was a group of three statues, cut from a single stone, the principal being that of Osymandias seated, the other two, his mother and daughter, each standing at his knee. The foot of this statue measured ten feet and a half. On it was inscribed, "I am Osymandias, king of kings. Whoever will dispute with me this title, let him conquer me in any of my works."

The tomb contained also a separate statue of the mother, with the figures of three queens on her head, to intimate, says the ancient authority, that she was the daughter, wife, and mother of a king. After this you entered a peristyle even more beautiful, on the walls of which were sculptured scenes from the king's wars and victories. It was open to the air, and in its centre was an altar of marble. From here three gates led to an edifice 200 feet square, the roof of which was supported by magnificent columns. It contained carved wooden figures, representing a court of justice. Beyond this was a spacious avenue surrounded by splendid edifices, devoted to the banquet, the library, religious ceremonies, and retirement; and at the end of it was the ascent to the royal sepulchre, the summit of which was crowned by a circlet of gold 365 cubits (the days of the year) in circumference and one in thickness, on which were engraved representations of sunrise and sunset, and astrological symbols. Such, according to historians, was the tomb of Osymandias in Thebes, before the Persian king came to slaughter and destroy. Only the remains of two colossal figures indicate now the spot on which it stood; these are believed to be two of the group above mentioned.

THE VALUE OF A VOICE.

A CERTAIN class of persons are spoken of as being born with a silver spoon in their mouths. They have perhaps, inherited a ready-made fortune, or have been so lucky or prudent in all their ventures that they have quickly acquired one without much trouble. But there is another class to whom the saying can be more literally applied. We mean those who have been gifted with such charm and power of voice, that they are able to name their own terms upon which they will consent to let their fellow-creatures hear them sing.

As one example we might mention Jenny Lind, who so delighted the ears of a past generation that her name still lives, and is remembered in all English-speaking countries. But modern times furnish a still better instance of the marvellous sums that can be obtained for their services by those few gifted ones who still possess the faculty of holding their hearers enthralled by their sweet notes. Many a professional man, whether he be a clergyman, a lawyer, a doctor, or what not, would count himself fortunate if he could command for his yearly income the sum earned in one evening by one of these human nightingales. Let us make our words good by reference to a letter addressed to one of the leading papers by Mr. Mapleson, the well-known *entrepreneur* of the Italian Opera Company. In speaking of the salary payable to Madame Adelina Patti, during a projected tour of the company in the United States, he says, "Madame Adelina Patti is engaged to me for six months, commencing in October next, to sing at least twice a week, for which she is to receive £917 a night. The sum of £9,170 has been already placed to her credit at her banker's in New York, as a guarantee for the payment of the first ten nights' services. In addition to this, Madame Patti will have her private Pullman travelling-car, containing drawing and dining-rooms, kitchen, and sleeping accommodation, for the whole of her servants, as well as two cooks, who will accompany the expedition."

There is no doubt that Madame Patti stands alone in some respects. She not only possesses a marvellous voice, but great musical efficiency, and wonderful dramatic power; and such a combination of gifts is seldom found embodied in one person. She can therefore command the stupendous income stated in the letter which we have quoted. But we must all the same deplore the circumstances which compel the payment of such an amount to a *prima donna.* It is a drain upon the resources of an opera company which affects others in no small degree. The minor singers must, of course, be contented with far smaller salaries; therefore, the next best *artistes* can hardly be induced to appear, and the prices of admission to the audiences must be so high as to shut out the general mass of the public, and so retard that education of the ear without which the enjoyment of good music is impossible. The practical result, in fact, is to sacrifice all general interests, that a few may have the pleasure of hearing one great singer. But the pecuniary value of that special gratification is none the less remarkable.

HAIRY HUMAN BEINGS.

THE quantity and kind of hair on the human body varies in different races. The Mongols, and other Northern Asiatics resembling them, are noted for their scanty beards, and a general deficiency of hair, and the same statements are made with respect to the native tribes of America. In other races, and notably in the Ainos, or in the Kurilian race, there are individuals who have hair growing down their backs, and nearly covering their entire bodies; they are, in fact, in an extraordinary degree, the most hairy *people* in the world. "Their beards," says La Pérouse, "hang upon their breasts, and their arms, necks, and backs are covered with hair," and he adds, "I note this as a general characteristic, for it is easy to find individuals equally hairy in Europe." Broughton describes them as "having their bodies covered almost universally with long black hair," and says this was the case with even some young children.

Miss Bird, describing her travels in Japan, speaks of the Ainos as a people who are covered almost completely with hair, and have features resembling the European type. She says they number as many as twelve thousand, and live near the sea in a mountainous district of the country, of which they are said to be the original inhabitants. She also affirms that physically and morally they are superior to the Japanese. So thick and long is their hair, says Miss Bird, that they need no other clothing either for covering or warmth.

But the most astonishing growth of human hair on record, is that of the family our engravings represent. The two persons represented both belong to the same family, the second being Krao, a girl who was recently shown to the public at the Westminster Aquarium. They were natives of Burmah, or the Empire of Ava, which is bounded on the north by Tibet and Assam, on the west by Bengal, on the south by the Gulf of Martaban, and on the east by the Empires of Annam and China.

Mr. Crawford, who first called attention to this wonderful family, says: "When we were at the capital of Burmah, Aingwa, or Ava, in 1826, we heard of a native covered with hair, and having the appearance of being an ape rather than a man, although there is nothing in him to justify a belief in his being other than human, or, as some have imagined, a missing link. When we manifested a strong desire to see this individual, the Bod, or Emperor, permitted us to do so: therefore Dr. Wallack and myself were able to take down from the man's own lips the following particulars of this remarkable case. The peculiar growth of hair by which he was distinguished had also distinguished others of his family in the preceding generations. His name was Shwe Maon, and he was in his thirtieth year. He belonged to the district of Mae-Yong-Gye, in the county of Laos, by the river Saluen, three months' march from Ava. He had been given to the Emperor five years before by Sambwa, a native chief, and had ever since remained at Ava. He is in height about five feet three (about the average height of the Burmans) of a more frail and delicate appearance than characterises the Indo-Chinese race. His eyes are of a dark brown, but somewhat lighter than is common in Burmah. The entire face of this man—mouth, nose, inside the nostrils, the forehead, cheeks, chin, &c., the lips only being excepted, are covered with a thick growth of fine hair, eight inches long on the forehead and cheeks, and about four inches long on the nose and chin, very smooth, silky, and straight, and in colour of a silver grey. The ears, inside and out, are covered in the same way. He has,

PORTRAIT OF SHWE MAON.

properly speaking, no eyelashes, eyebrows, or beard, the hair on these parts being the same as that on other parts of the face. The body and limbs are also covered with hair, least plentifully from the shoulder to the spine, where it is five inches long. On the chest the hair is four inches long. It is less plentiful on the arms, legs, thighs, and stomach. We inquired if the hair was shed periodically, but were assured that it was not. Although, as already said, he was only thirty years old, he had the appearance of being about double that age. Examining his mouth, we found a peculiar formation of the lower jaw-bone, and discovered that he had but five teeth in the inferior jaw, four incisors and one canine, on the left side, and that the other jaw had but four teeth, which resembled those of animals. The molars were absolutely wanting, and the hard gums gave no indications of other sockets; indeed, Shwe-Maon assured us that he had never had more. His milk-teeth were shed when he was in his twentieth year. His proportions for a Burman were good, and he appeared to have great intelligence with much good sense; by trade he is a basket-maker. At his birth, he told us, only his ears were covered with flaxen hair about two inches long. This, when he was six years old, had covered his whole body, coming at first only on the front portion. In his twenty-second year he married a woman by whom he had four children, all girls. The eldest died in her third year, and the youngest eleven months after her birth. The mother, who was of a pretty Burmese type, graciously showed us the two remaining children, the younger of whom strikingly resembled her. The elder had nothing unusual in her appearance. Her little sister is puny, and had, when born, hair growing over the outside of her ears; at six months she was entirely covered with a silky down, and in a year her whole body was covered with shaggy hair, soft to the touch, and of a flaxen colour. At two years she had a pair of incisors in the jaw, but there are at present no signs of canine teeth or molars. Shwe-Maon assured us that he had never known any family but his own having their peculiarities."

KRAO.

Twenty years after the above description was written, Captain H. Yule saw the same family. "The younger daughter was then a woman, and her entire body was covered with hair. Her name was Maphoon. Portions of her cheeks and the upper lip were covered with soft brown hair, short in length; the hair on the nose was about five inches long, and at the sides of it very thick and bushy, her ears being also thickly covered within and without, except on the upper portions, so that they were completely concealed. The hair of her face and that of her head blended, the latter being dressed *à la Chinois*, the hair on the nose was longer than he had seen it on that part of any other animal, falling in thick bushy divisions to the right and left. The moustache resembled that of a dog, and the dark hair on the cheek was soft, and about four inches long. Her voice was feminine and pleasant, and there was nothing at all disagreeable in her expression after the first glance, which conveyed, somehow, an impression of her wearing a mask. Her throat, arms, and neck are overgrown with hair varying in colour as the light changes. When we saw her, she proceeded to remove some of her clothing, but without any loss of modesty, and not without a natural degree of hesitation and shyness. She was accompanied by her husband and her children, two boys. The eldest, about four or five years of age, had no unusual peculiarities, but the youngest, who was about four months old, and at the breast, evidently resembled his mother. His head had but little hair, his ears were garnished with silken tufts of hair, and his baby face looked oddly with its military-looking moustachios. The infant's appearance was, we were told, just that which his mother had at the same age. Maphoon had the same dental peculiarities that her father had, she was without canines and molars, and the gums had the same hard, unbroken surfaces."

Six or seven years after the visit of Captain Yule, Captain Haughton visited the family and photographed them. Maphoon's youngest child was then near the adult age. Maphoon herself was once courted by an Italian, who wanted to marry and exhibit her in Europe, but she refused him.

Krao, who in 1883 was about eight years of age, is covered with sleek, shaggy hair, and in many of her ways resembles a monkey, being able to throw herself from one place to another, suspending herself by her feet, and to pick up the most minute objects from the ground with great quickness and certainty. But these peculiarities do not suffice to establish her connection with the much-talked-of and vainly-searched-for missing link between man and monkey. Mr. Keane, the anthropologist, has carefully investigated her case, and pronounces her to be most decidedly human and nothing else. He believes her existence gives certainty to the statements that in Laos exists a "very hairy" race of men, resembling the Ainos of Jesso and Sachaline.

Instances resembling the above are not unknown to Europe, where the extraordinary growth of hair recorded at different times in connection with both men and women is more curious in the latter than in the former, and, strange to add, least rare. In 1665, a woman named Barbara Urslerin, or Urselin, at the age of twenty-two had her body entirely covered with light yellowish curling hair. She had also tufts of hair pendant from her ears, and a long beard reaching to her waist. She was exhibited for money in various parts of England and abroad by her husband, who had married her for that purpose.

An old work, called "The Book of Curiosities," (1822), describes the portrait of a woman preserved in the Museum of Curiosities at Stutgard, in Germany, as that of Bartel Graetje, painted from life in 1787. She has a large beard. Another woman with a beard of unusual length and thickness was painted by command of the Duke of Saxony, in whose collection of pictures it was long preserved. Charles XII. had a bearded female of great strength and courage who had enlisted as one of his grenadiers. She fought at Pultowa, where she was taken prisoner, and being carried to St. Petersburg was, in 1724, presented to the Czar. Her beard was then a yard and a half in length! In 1726 a bearded female dancer was exhibited during carnival time in Italy. In the Trevoux Dictionary mention is made of a woman who had a large beard, and whose entire body was covered with hair. Margaret, ruler of the Netherlands, had, we are told, a long stiff beard, of which, strange to say, she was very proud.

Evelyn, writing in 1684, says he saw a hairy woman with beard, moustaches, and long locks of hair hanging from the middle of her nose. She was, however, the Barbara Urslerin already spoken of.

POISON-EATING.

In the year 1830 Monsieur Chabert, known as the "Fire King," professed his ability to eat certain deadly poisons with perfect impunity, phosphorus and prussic acid being taken in the presence of medical men, invited to be present and detect imposture if possible. The general belief was that he contrived to use the poisons first and antidotes afterwards, but how he administered the latter does not appear to have been discovered.

The learned Samuel Purchas has chronicled the case of Marchamut, a Moor, who, he writes, "deserveth mention for one thing, wherein the sunne hath scarce beheld his like. He so accustomed himselfe to poysons, that no daye passed wherein he took not some ; for else he himself had died, sayth Barbosa, as it fareth with Amfian, or Opium, the use whereof killeth such as never tooke it, and the disuse such as have." (1612).

The same old writer says : "Cœlius Rhodiginus mentions the like of a maid thus nourished with poysons, her spittle being deadly. He cites a like example of Avicenna, of a man whose nature, infected with a stronger venome, poysoned other venomous creatures."

In the course of a very interesting trial for murder which took place in Austria between thirty and forty years ago, some curious evidence as to the existence of systematic poison-eating was produced. It was then pointed out that in some districts of Lower Austria, and especially in Styria, arsenic was in regular demand for eating, mostly with a view to the improvement of the complexion and acquiring plumpness, but sometimes to improve or strengthen the breathing powers; and that numerous deaths were caused by it, especially amongst the young. They began by taking a very minute portion several mornings in each week while fasting. The dose was very slowly and carefully increased. One peasant, a hale strong man of sixty, stated that he then took for a dose about four grains, and that he had eaten arsenic for more than forty years, as his father had eaten it before him. It is a curious fact that when those who have accustomed themselves to poison-eating are unable to obtain the arsenic, or are trying to do without it, they grow sick, and their symptoms are those of arsenical poisoning. In some districts corrosive sublimate is used in the same way. Dr. von Tschudi states that it is so used in the mountainous parts of Peru and in Bolivia. Dr. Pearson says that one-sixteenth part of a grain of arsenic may be taken with impunity, and it is often used in the cure of agues, but the practice of taking it has a tendency to create a morbid appetite which is sure to end in very seriously injuring the constitution, and often kills.

SUNSHINE RECORDS.

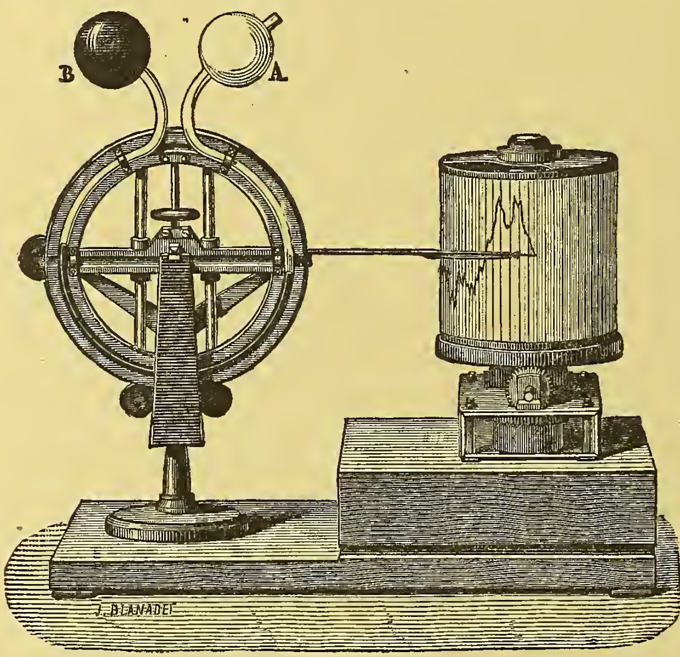
Two strangers meeting in a railway carriage and wishful to converse with one another, invariably break the ice with some remark upon the weather. Farmers, builders, fishermen, sailors, and hosts of others whose living depends upon the question, discuss the chances of sunshine or rain with still more intense and natural interest. In short, there is no civilised being on earth to whom the word "weather" lacks meaning. The importance of the subject has now long been recognised by scientific men; and as one result we have daily forecasts of the weather that may be expected during the next twenty-four hours — such forecasts being familiar items in our several daily newspapers. It is true that these returns from the Meteorological Office are often inaccurate, and persons unaware of the care and labour bestowed upon them are apt to regard them as altogether valueless. But careful comparison of the forecasts with the weather eventually vouchsafed to us will prove that about 75 per cent. of the calculations come true.

This information is collected by comparing the barometers at different stations over the whole country—a work which is rendered possible by the electric telegraph. In addition to the barometer, we have many other instruments devoted to meteorological research, and records from these are noted each hour of the day. The pressure of the wind, the appearance of the clouds — secured by photography—the amount of rainfall in each district, may be mentioned as subjects of careful scrutiny. Within quite recent years a method of recording sunshine has also been contrived—and as an aid to weather wisdom perhaps these records will eventually prove more valuable than any of the others. Let us endeavour to trace the methods which have been adopted from time to time, and which have gradually led up to the very perfect instrument called the Radiograph, which forms the subject of our illustration.

As far back as the year 1857 we find in a report of the Meteorological Society the account of a registering sun-dial by Mr. Campbell of Islay. This instrument was constructed to give in a rough manner a record of the amount of sunshine which fell upon it. It consisted of a glass globe full of water—like that used by engravers to concentrate light upon their work—which was fitted into a hollow wooden bowl. It acted just like a burning-glass—the wood inside the bowl being charred at the spot where the sun's rays were collected. This spot, of course, changed its place as the sun rose and fell in its apparent path across the sky. The result was that the record took the shape of a charred line, with blank spaces to represent the periods when clouds crossed the sun's disc. The water globe was afterwards replaced by a sphere of solid glass, and for twenty years records—such as they were—were obtained in this primitive manner. The next step in advance was to employ a stone bowl, covered inside with a black varnish, which was melted as the sun's heat acted upon it. The instrument finally was rendered more efficient by employing a strip of paper ruled with the hours of the day, upon which the sun could trace a scorched line. And in this modified form it has been in use within quite recent years. It will be observed that the record obtained was merely one of duration, and gave no indication whatever of the intensity of sunshine.

A far more efficient and accurate recorder was later on invented by Mr. Winstanley. This consisted of a balance, or beam, hung just like one in an ordinary pair of scales. This easily-oscillating beam carried a glass tube charged with mercury, and crowned at each end with a glass bulb full of air. One only of these bulbs was exposed to the sunlight, with the result that whenever the sun shone the air within it became expanded and drove the mercury towards the other end of the balance. The weight of the mercury thus forced the beam to descend, and an attached pencil made a mark upon a horizontal and revolving clock-dial. A pencilled record was thus obtained of every minute period of sunshine at the exact time of its occurrence. This instrument, however, merely noted duration, not intensity; but the same inventor soon proceeded further and produced an instrument in the Radiograph, which fulfilled in a most perfect manner both conditions recording both.

A glance at the illustration will show that the Radiograph so far follows its prototype as to possess a mercury tube with a bulb (B A) at each end. The tube follows the outline of a circular frame, which is balanced upon a knife-edge, so that it is free to sway from side to side as the weight of the quicksilver is thrown one way or the other. One bulb is blackened so that the heat is absorbed by it. On the same principle a black coat in the sun is hot to the hand, while a white one is quite cool. On the



THE RADIOGRAPH.

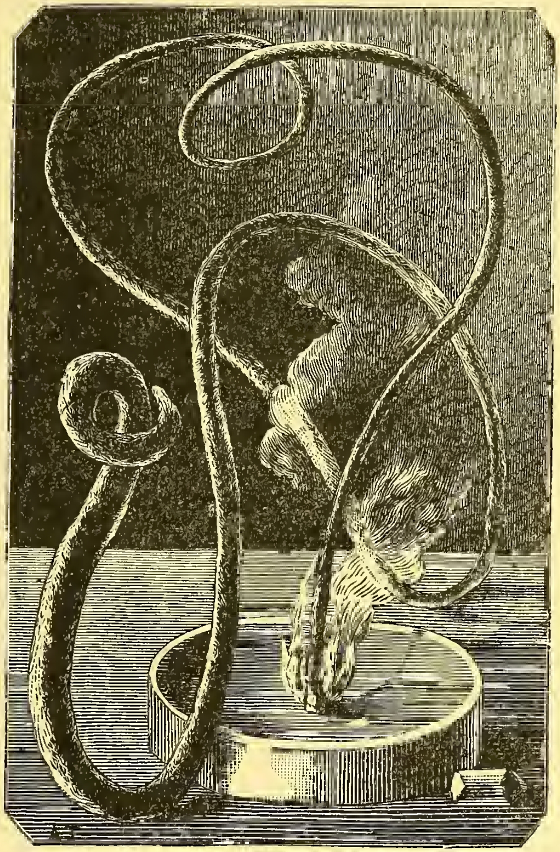
right-hand side of the instrument is seen a drum which revolves by clockwork, and on this drum is bound a sheet of paper blackened in the flame of a lamp. A needle fixed to a projecting arm on the balanced instrument is so adjusted that it just touches this blackened surface, and supposing that it kept still it would trace a continuous line on the moving drum by scratching the lampblack from the surface of the paper. But every gleam of sunlight acts upon the balance by expanding the air in the bulb B, and the needle is caused to trace a vertical line as it moves upwards. The most fleecy cloud passing across the sun is noted, and the difference in intensity of heat as the sun gains the meridian and begins its westward journey is shown by the length of the line traced. It is a curious fact that the Radiograph gives slight evidence of movement even before sunrise, and that just after midnight its needle rises above a strict horizontal line. It is difficult to account for this, but it occurs too regularly to be ascribed to mere accident.

In conclusion, we may refer to the attention now being paid to solar physics, and more particularly to that branch which seeks to obtain evidence of the effects of sun-spot periods on our globe. That there is some influence exerted by these disturbances in the sun's glowing atmosphere there can be little doubt. The Radiograph ought to prove an efficient help in the endeavours that are being made to solve a difficult problem.

PHARAOH'S MAGIC SERPENTS.

A CHEMICAL experiment is always an attractive thing, even to those who know nothing of chemical science. The innate love of the marvellous, which is common to human nature, is fed by watching such experiments, and the more they partake of fire and smoke—to say nothing of noise and smell—the more popular they seem to be. A chemical experiment usually consists in putting together two different substances, which unite to form a new body, generally quite different in appearance from either of its constituents. Thus sulphur and mercury ground together, on the application of heat, unite to form the beautiful pigment known as vermilion. In like manner a salt of iron can be made to combine with the yellow wax-like crystals of prussiate of potash to give us that colour called—from one of its parents—Prussian blue. And so on, with nearly all the colours to be found on a painter's palette. We could, with some profit, enlarge upon this theme, and show how, by other chemical changes, far more important results have been realised, and how many an industry—nay, many a large town—owes its prosperity, if not its existence, to chemistry.

From such results, which border upon the sublime, we can easily descend to matters trivial in comparison, to show how chemistry may assist the toy-maker. The various kinds of crackers, from the vulgar "throw-down" to the æsthetic supper-table bonbon-container, owe their noise to one of the most powerful and dangerous explosives known to chemistry, namely, Fulminate of Mercury. An ounce or two of this compound would be sufficient to wreck a house; but a fraction of a grain is sufficient for a cracker. Another chemical toy, which was a great favourite only a few years back, and formed something more than a nine days' wonder, is named Pharaoh's Magic Serpent. This little contrivance forms a capital illustration of the manner in which chemistry can be applied to toys; and to the method of its manufacture we will now devote a few lines.



A PHARAOH'S SERPENT.

As bought in the shops, this chemical toy has the appearance sometimes of a little pyramid (which, perhaps, is its only point of connection with the Pharaohs), and sometimes of a white pill. It would, perhaps, be more correct to describe the latter form as that of an egg, for it is more reasonable to suppose that an egg should produce a serpent than that a pill could do so. However, the egg, or pyramid, is put on a plate, a match is applied to it, and the thing soon begins to establish its kinship to the reptile creation. From this egg—little bigger than a pea—a brown snake-like body emerges, coiling itself into wonderful convolutions, until its total length amounts to perhaps twenty inches or more. Its abnormal growth suddenly ceases, the lambent flame which played around the egg during this hatching process has now disappeared, and we can examine our serpent at leisure. We find it very different from the animal it roughly represents, for instead of being a lissom body, which can be bent at will in any direction, it is extremely brittle; the least touch will cause it to crumble, and its lightness suggests the truth, that what we have before us is simply the ash of the original compound.

We will now give different formulæ for preparing these interesting toys; but we must caution those who would make them that the serpent egg and its product are both poisonous. The vapour given off during combustion is also deleterious in its nature, so that the experiment should not be attempted in a closed room, and when concluded the residue should be thrown on the fire.

I. Fuse in a crucible the following mixture:—Prussiate of potash, 46 parts; sulphur, 32 parts; carbonate of potash, 16 parts. The heat should not be allowed to go beyond a dull red, and the crucible should be removed from the fire when the contained mass seems to be thoroughly fused. When cold, the fused mass is dissolved in water, and the clear portion of the liquid filtered off. To this latter is added nitrate of mercury, so long as a precipitate is thrown down. This precipitate is washed in many changes of water, collected on blotting-paper, dried, and finally rolled into little pyramids, or eggs, and covered with tin foil. They are now ready for ignition. The mixture thus compounded is sulpho-cyanide of mercury, which can be produced by the following method if preferred:—

II. Metallic mercury is dissolved in dilute nitric acid, taking the precaution that there is present an excess of the metal. Decant solution, and add to it a saturated solution of sulpho-cyanide of ammonium. The precipitate which falls must be collected, washed in several changes of water, and finally dried. Mix in a mortar this dried product with a little gum-water, so as to make a pasty mass as dry as possible. This compound can now be formed into eggs or pyramids as already described.

As we have already indicated, the compound produced in both cases is identical, and it is extremely poisonous. We now give a recipe for making serpent-eggs which have not this disadvantage, which do not give off mal-odourous vapour, and which leave an innocent residue that may be preserved for a useful purpose. For all these reasons it is to be preferred to either of the others :

III. Bichromate of potash, 2 parts ; saltpetre, 1 part ; white sugar, 3 parts. Pulverise these ingredients separately. Mix them thoroughly, and then press the mixture into little cones, which have been previously formed out of thin paper. If not wanted for immediate use, the cones should be covered with tinfoil, and then varnished ; after which treatment they will keep for a long time uninjured if placed in a dry situation. A little balsam of Peru added to the mixture before it is put into the cases will cause the serpent to give off an agreeable perfume during its production. The residue is a mixture of carbonate of potash, oxide of chromium, &c., which, when pounded up and kept in a corked bottle free from moisture, forms an excellent polishing-powder for various metals.

THE SEWERS OF LONDON AND PARIS.

WHENEVER great numbers of people are located in one spot, cleanliness becomes a matter of the most serious concern. Armies encamped in hostile countries have often suffered from the ravages of disease, as in the case of our own army during the Crimean war, purely from the absence of some means or other for the effective removal of the impurities that man, in common with the rest of animate creation, continually throws off. For this purpose the Jews kept a furnace, called Gehenna, constantly burning in the valley of Hinnom. Here they burnt all the refuse of Jerusalem every day, and burnt likewise along with it the bodies of their criminals. In modern times few problems have taxed human ingenuity so much as the sewage question, and the works that have originated in our large centres of population, from the pressing necessity of effectually disposing of the waste products of life, are to be reckoned amongst the greatest of public achievements. Accordingly, we shall endeavour to give the reader a slight idea of the elaborate systems whereby towns of the magnitude of Paris and London are kept not only clean, but are actually more wholesome to live in than many less densely populated places. Indeed, so necessary is good drainage now considered for the happiness and health of man, that before a street is built the drainage is first considered. Not many years ago, however, the street was first built, and the drainage was left to take care of itself.

Paris being situated wholly within the valley of the Seine, this river naturally became the receptacle for the sewage, and its waters, once so pure that the fish might be seen speckling its white sandy bottom, became, as the city grew, blacker and filthier than the horrid Stygian stream of ancient fable. The gay city of Paris itself was fast becoming one foul cesspool ; its subsoil was putrid ; odours of the most unwholesome description floated from the humble cot to the palace of the noble, until, at length, the dreadful ravages of cholera awakened men to the pressing necessity for sanitary reform. The result of this awakening was the projecting of a scheme for the thorough drainage of Paris, which, completed in 1855, transformed the French capital, and led the Parisians to say that another Paris had been created underground.

This subterranean Paris, which, from the fact that the drains are named from the streets above them, may be regarded as an exact counterpart of Paris itself, consists of sewers and collectors. The sewers receive the street and house water, and conduct it to the collectors. These collectors, numbering three in all, stretch along the lower levels of the city, and thus receiving the natural drainage as well as the contents of the sewers, bear their strange freight to the Seine at a point below the limits of the city. The size of these collectors seems to be very little less than that of the tunnels of the underground railway of London, and of the two the collectors would seem to be the more desirable place to be in—indeed, a visit to the sewers of Paris is regarded as a pleasure trip. Upon the edges of the side-walks with which the collectors are furnished, are rails for waggons to run on. These waggons, consisting of a light frame, carry a board, which on being lowered into the channel between the side-walks dams up the stream. The head of water thus formed being suddenly released, carries with it any obstruction in the shape of sand or mud that may have stuck in the waterway In the largest channels boats are used instead of waggons. These boats, built of iron, carry a similar dam-board, which is manipulated in much the same way, and for the same purpose as the boards on the waggons. The rate of sailing is extremely slow, taking from eight to ten days to traverse five miles. In returning up stream, movable dams are placed in the channel about every 600 yards to reduce the speed of the current. The smaller sized sewers are cleaned out with rakes and shovels. The cost of thus maintaining the cleanliness of underground Paris is reckoned at £30,000 per annum. Several hundreds of workmen are continually employed for this purpose, and there are thousands of safety chambers and points of egress to facilitate their escaping from the sewers in case of sudden flooding. In July, 1872, a storm broke over Paris ; the rain poured ; the water rose in the sewers, burst through the street gratings, and swept many of the workmen away.

These Titan tunnels, besides draining Paris, are used for the water-mains, the gas-pipes, and telegraph-wires, and along their sides run the tubes of the pneumatic despatch. This does away with the necessity of continually ripping up the streets and interfering with the street traffic whenever anything goes wrong with the water or gas-pipes. In the thickness of the wall of some of the sections are offices for clerks and lamplighters ; "lights enclosed within porcelain globes hang from the iron columns ; rails and trams are seen through the long perspective of semi-darkness ; farther on, boats and barges, manned by pilots of a singular navigation, float upon a stream calling up Acheron." The most repulsive feature about the sewers of Paris seems to be the rats, which are here bred in their worst and most ferocious form. These rats, moreover, long enjoyed the protection of the officials for the sake of their skins, which afforded a great supply to the kid-glove-making trade and other industries of Paris ; possibly, also, the cook-shops of Paris now and then replenished their larders from this source ; at least the Parisians are said to have had recourse to these creatures during the last siege.

Before London had acquired its present main-drainage system, it was drained directly into the Thames. At first the ditches and brooks—such as the Fleet Ditch, Bayswater Brook, &c.—together with cesspools, assisted the Londoner to get rid of his sewage. These ditches, however, in process of time became a nuisance, for we read that—

> Drowned puppies, stinking sprats, all drenched in mud,
> Dead cats, and turnip-tops came tumbling down the flood.

The result of this was that these natural streams, having been putrefied with filth, were next covered. Improvements went on apace, and the Thames grew dirtier, breathing forth sickness and disease upon those that lined its banks. None of the improvements were in the right direction, for, no matter how rapidly the sewage was shot into the Thames, the tide only kept it dancing up and down the stream, while it underwent putrefaction within the limits of the city itself. Another nuisance was the effect of a flood. When the river rose to more than its usual height, it would choke the sewers that discharged themselves into it, and the sewage would in this way be backed right up into people's houses, especially those situated in the lower levels of the town. This was altogether too much for the wealthiest city in the world to put up with ; so the intercepting scheme now in vogue, and designed by Sir Joseph Bazalgette, was begun in 1855—just the year in which the scheme adopted for Paris was completed.

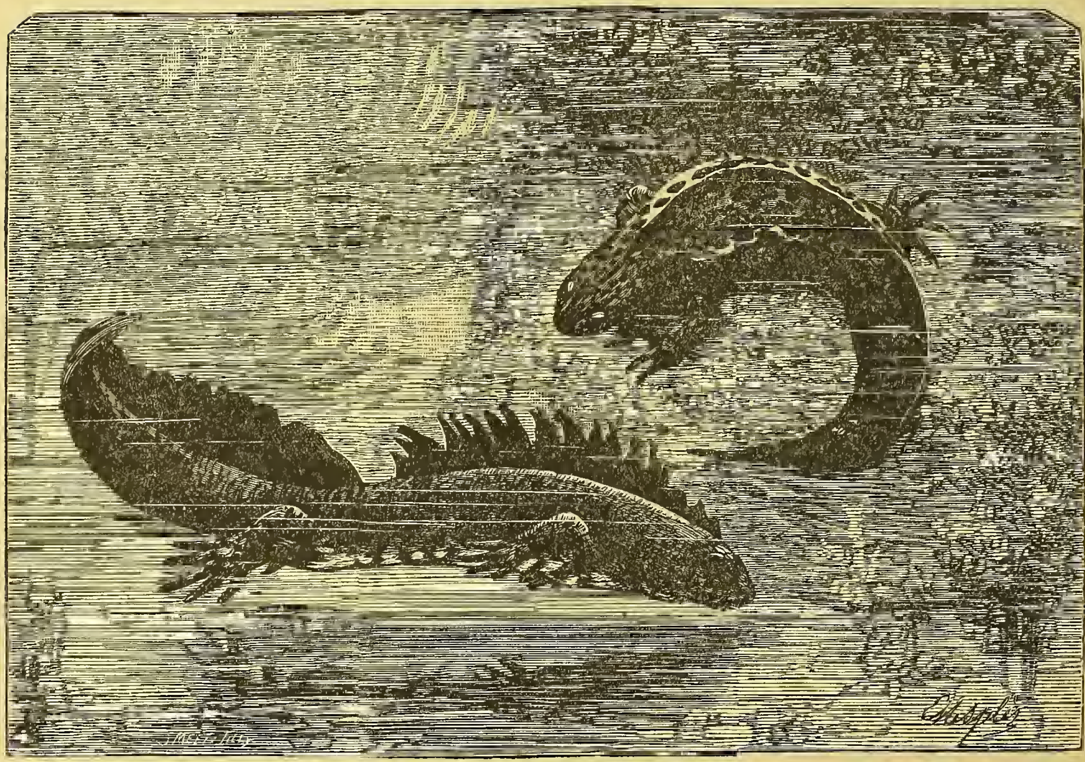
The intercepting sewer-mains are six in number —three on the north side of the Thames, and three on the south side. They run parallel to the river, and intercept the sewage as it flows along the former main sewers in the direction of the river. This is conveyed as far east as Barking and Woolwich, where it is discharged. The reason for making the outfall so far down the river is to prevent the tide from bringing it back into the metropolis. The length of the intercepting sewers is 82 miles, and the cost of carrying out the scheme was £4,100,000.

To give a proper description of the drainage of London would take up too much space ; perhaps, however, an idea of the magnitude of the works may be gleaned from the following facts :—There are in all upwards of 1,300 miles of sewers in London. In constructing the main intercepting sewers alone 318,000,000 bricks were used ; 880,000 cubic yards of concrete were consumed, and 3,500,000 cubic yards of earth were excavated. The flood that rushes through this vast network of tubes is between sixty and seventy millions of cubic feet per day, which would form a lake covering an area of 482 acres and 3 feet deep, or fifteen times larger than the Serpentine in Hyde Park. The coal annually consumed at the pumping stations exceeds 20,000 tons. We have, surely, reason to expect better health than our ancestors after such an outlay as this ; and, indeed, recent figures show that the expectation is justified.

NEWTS.

THE animals known by this name, or often, in rural districts at least, as "efts," are usually regarded as reptiles by those who are not versed in zoological lore. Scientifically, they are not "reptiles." They are included by naturalists in the class of "amphibians," or that which has the frogs and toads as its most familiar representatives. These animals and the newts together, differ widely from true reptiles. Thus, if we look at the latter, we see they possess scales, or even, as in the case of the turtles and crocodiles, bony plates, as a skin-covering. The newts and frogs, on the contrary, do not possess scaly bodies. The newts are often mistaken for lizards, to which they certainly bear a resemblance in outward form ; but they may be at once distinguished from these reptiles by the want of scales. There are other characters, however, in which frogs and newts differ widely from all reptiles. Thus they begin life as gill-breathing tadpoles, and thereafter develop lungs ; for although the newts mostly live in water, they have to come up to the surface to breathe air directly from the atmosphere. The gills disappear in newts and frogs in early life, leaving the adult animal to breathe by lungs alone. This curious feature of their early life, namely, that of beginning existence as "tadpoles," under a different guise from that they exhibit as adults, is highly characteristic of all amphibians ; reptiles, on the other hand, do not undergo such a "metamorphosis," as it is called. The changes they exhibit are all gone through within the egg, and not outside the egg, as is the case with the frogs and newts.

The newts form a widely-distributed group of amphibians. Certain members of the newt group retain their gills throughout life, and, as adults, thus come to breathe through gills and lungs together. Such are the *Proteus* and the *Axolotl*—the former found in underground caves of Central Europe, and the latter in North America. The latter continent may, in fact, be viewed as the great headquarters of the newt race. One of the most noteworthy of the newt group is the Giant Salamander of Japan, which attains a length of three or four feet. The name "Salamander" is in fact given to the "newts" at large, the "Land Salamanders" and "Water Salamanders" being the two natural divisions into which the group falls. The legend of the salamanders being able to live in fire probably sprang from a germ of truth, like most other fables relating to the animal world. These animals possess large skin-glands, from which, when irritated, they give off quantities of a watery fluid. It is more than probable, therefore, that, under the irritation of fire or heat, some of these animals having been known to give off this watery fluid, the fact became in time exaggerated into a power of quenching fire, or of existing amid the flames.



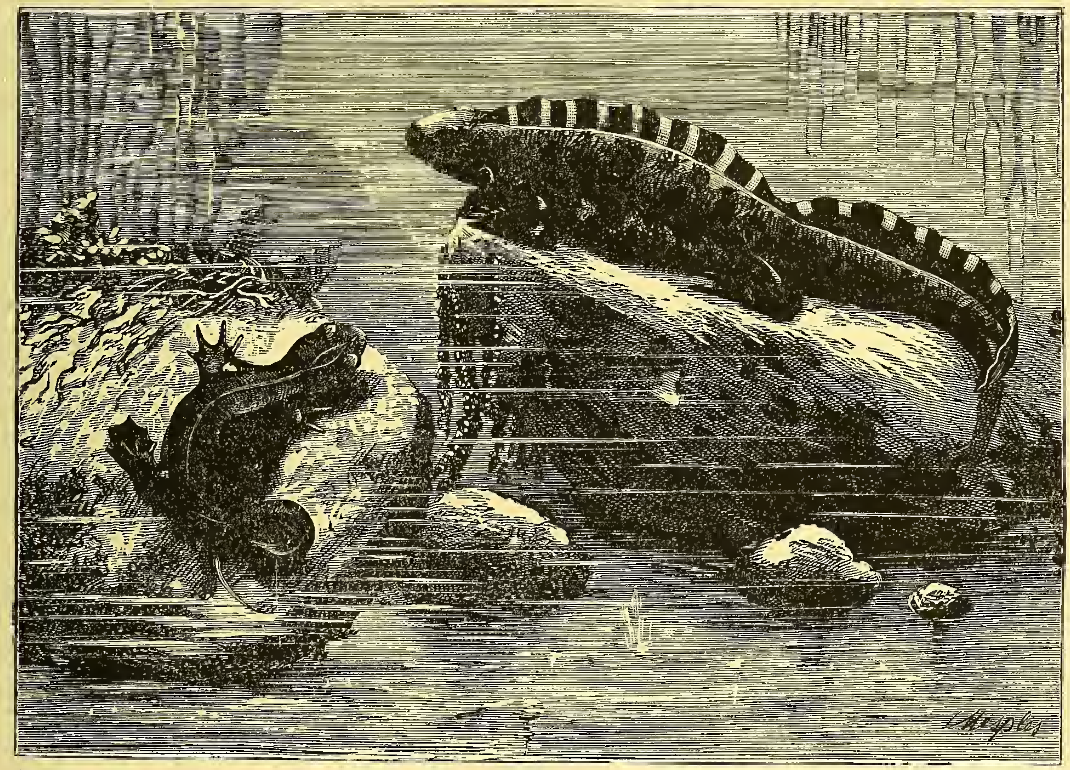
THE CRESTED TRITON (MALE AND FEMALE).

The newts are familiar denizens of our ponds and ditches, one of the most familiar species being the Crested Triton, or Great Water Newt, the male of which develops a prominent crest during the breeding season. The average length of these newts is between three and six inches. Their colour is blackish brown above, and bright orange below, speckled with black. Amongst other familiar species are the Palmated Newt, which has the hind feet webbed in the male, and the Spotted, or Marbled Newt. The latter is found in the south of France in tolerable plenty.

A curious feature of the newt tribe is the apparent facility with which they reproduce lost limbs or tail. New limbs, or a new tail, grow in place of lost or amputated members—a process of repair which possibly owes its characteristic chiefly to the fact of the animals being cold-blooded, and to an absence in them of the shock and pain which such an operation would produce in higher life.

The eggs of these animals are deposited on the leaves of water plants in a highly ingenious position. The leaves are doubled back by the mother-newt so as to enclose the eggs, the edges of the leaf being apparently glued together with some sticky secretion. This process can be watched without difficulty in a large fresh-water aquarium, of which either of the common newts of Great Britain will be found amongst the most attractive denizens. It ought, however, to be remarked that the larger newts have a great propensity to devour, if other food be short, either the smaller varieties or their own young, and measures should be taken accordingly.

Amongst the most wonderful traits of newt-history are those which relate to the changes undergone by the *Axolotl*, an American newt. This animal was long regarded as a mature form. It possesses gills and lungs in its adult state, lays eggs, and produces its like as if it were an adult. Yet in 1867 Axolotls were seen to leave the water in which they were confined in Paris, cast all their gills, shed their skin and tail, and assume the exact likeness of another American newt, the *Amblystoma*. The explanation of this curious change probably lies in our recognising the fact that the Axolotl is simply the young, or tadpole form, of the Amblystoma, and that it has become mature as a tadpole, and assumed the likeness and functions of a full-grown species.



PALMATED NEWT AND SPOTTED NEWT.

The Black Alpine Salamander is another newt possessing a highly curious history. This newt lives in dry places in the Alps, and its young undergo their metamorphosis whilst still within the egg and enclosed in the body of the parent. We see in this curious method of development another wonderful adaptation to the altered life and habits of the species.

BEARDS.

ONE Easter Sunday morning, Guillaume Duprat, Bishop of Clermont—a man sufficiently distinguished in his own day as an ecclesiastic to sit in the Council of Trent, and whose memory has come down through succeeding generations as the builder of the College of Jesuits at Paris—entering the porch of his cathedral, found the inner door shut in his face, and three dignitaries of the chapter awaiting him. In the hands of these dignitaries were a pair of scissors, a razor, a basin of warm water, a towel, and a piece of soap. On beholding these carnal weapons the Bishop retreated, and, escaping to his castle of Beauregard, two miles distant from Clermont, fell sick from vexation, and died of a broken heart. The cause of all this was Duprat's patriarchal beard—a beard altogether too fine for a bishop; and as the paramount opinion then held by the Church on the subject of beards was that pride was very apt to lurk beneath a well-developed appendage of this kind, a resolution had been framed to the effect that the Bishop should be shaved. The result of this resolution was the incident just recorded, and the untimely end of a good man. The reader unversed in beard-lore may experience some difficulty in believing this melancholy story. At the same time, however, it is quite true.

It is difficult for us—bustling sons of steam and electricity—to understand the high import attributed to the beard in former ages. A tradition, long extant, led men to believe that Adam was created with a full-grown beard, and this belief in many cases assumed the force of an article of religion. The Jews were forbidden to cut off the corners of their beards, and until very recently the stricter observers of the law, even if they shaved otherwise, accordingly left the sides of the whiskers towards the ears, if not round the face. Aaron's beard attracted the notice of his countrymen sufficiently to be commemorated in one of the Psalms, and enters into modern civilisation as the popular name of a very familiar and luxuriant plant. Every one knows that the favourite oath of the Mohammedan is by the *beard* of the Prophet, and, until the 16th century—when Selim I. shocked the faithful by shaving—the cultivation of the beard was reckoned an essential towards securing a safe passage to "the paradise of sherbet and ever-blooming houris;" the main reason for this being the fact that Mahomet himself never allowed a razor to touch his own hairy chin. The gods of the ancients, with the exception of *imberbis Apollo*, are all represented as bearded; Jupiter himself having a regular Alpine forest, which was an object of great admiration amongst the other gods and goddesses, especially when they wished "the father of gods and king of men" to grant them a favour. Thus Thetis, supplicating his good offices on behalf of her fiery son, Achilles, "took hold of his knees with her left hand and his beard with her right"—a most insinuating attitude.

The early literatures of ancient Greece and Rome show how highly the beard was esteemed by these nations. In the Homeric poems those characters who are to be conceived as dignified and possessed of authority are presented to us with *snow-white beards*; and, in the case of Rome, we have it on the authority of Livy that the Conscript Fathers deemed it an unbearable insult for a stranger to touch these symbols of gravity and wisdom. When that ancient city was forsaken by its panic-stricken inhabitants, and the Goths, dismayed it would seem at their own prowess, walking stealthily through the desolate streets, beheld the defenceless senators sitting in dignified silence at their doors, they were overawed until one of their number approached to stroke the beard of an aged senator. The bearded legislator instantly struck the rude Goth to the ground—a blow that was immediately avenged; for the savages forthwith proceeded to despatch the unarmed Romans. It is just possible, though we are not aware that any historian has yet sought to palliate the action of the Goth, that the senator may have been mistaken; for amongst many tribes there was no more impressive way of showing respect for a man than by manipulating his beard in some recognised way or other. A familiar instance in point will occur in the case of Joab and Amasa. When Joab approached the latter, he took hold of his beard to kiss him. It was because of this mode of salutation that Amasa took no notice of Joab's sword, and Joab's action in slaying him was all the more treacherous.

The Romans themselves soon began to discard the beard, and imported a number of barbers from Sicily about 300 B.C. They also it was who began to apply the term *barbarians—i.e.*, bearded—to the uncivilised; thus clearly evincing their profound contempt for what their ancestors had considered as at once an ornament and a sign of superiority. Alexander the Great, the Conqueror of the World, was not too great to bestow his attention upon the beard question. He compelled his warriors to shave, on the ground that the beard gave a handle to the enemy; and thus through utilitarian conside rations, shaving was begun in Greece.

It is curious to observe the different modes of treating the beard adopted by different nations. The young Roman allowed the down to remain upon his chin until there was a considerable quantity of it; then upon a fixed day, and with solemn ceremony, the razor was applied; the youth consecrating the tender sprouts to the household gods, and receiving formal visits from his friends, who usually marked their sense of the gravity of the occasion by bringing presents. Nero, we are told, consecrated his first beard in this way to Jupiter Capitolinus. From Tacitus we learn that amongst the ancient Germans, no young man was allowed to shave or cut his hair until he had slain an enemy. Cæsar tells us that the ancient Britons shaved everything "*præter caput et labrum superius*" ("except the head and the upper lip.") The Saxons wore long beards, but on the introduction of Christianity it became customary for the clergy to shave. This distinction between the clergy and the laity lasted for some time, and we find a writer of the seventh century complaining that the manners of the clergy had become so corrupted that it was impossible to distinguish them by their actions, but only by the beard. The Normans shaved the whole face, and when William the Conqueror's army was first sighted by Harold's scouts, they brought back the intelligence that it consisted entirely of priests. The early kings of France had a very curious way of ratifying important agreements; three hairs of the royal beard were affixed to the seal. Evidence of the truth of this custom is found in a charter dated 1121, which declares that it had been thus ratified. The beard continued to flourish in France until the accession of Louis XIII., who was beardless; the consequence was the courtiers soon became beardless too. His successor was also beardless, and this confirmed the custom of shaving. Spain was perhaps the best country in Europe for beards, and the Spaniards were passionately fond of them. Philip V., however, had no beard; beards accordingly disappeared from his court. The contagious example continued to spread, until at last the people, much against their will, it would seem, imitated the courtiers. Hence arose the Spanish saying:—"Since we have lost our beards we have lost our souls."

Peter the Great had perhaps more trouble than any other man in connection with the beard question. The Russians prided themselves on their square-cut beards. These Peter was determined to put down in his dominions. In the Russian's mind, however, beards were very closely associated with religion; indeed, the Eastern Church has always been partial to beards, whereas the Romanists have, in the main, been in favour of shaving. Peter ordered his subjects to cut off their beards. This command met with violent opposition. Peter persisted, and inaugurated a body whose duty it was to cut off by violence whatever beards might be still retained. To further aid the carrying out of this reform, he imposed a tax upon beards. Those that were unable to pay, religiously preserved the shorn beard, which was encoffined with them when they died, so that they might present it to St. Nicholas, lest he should exclude them from heaven as beardless Christians.

Individual beards have now and then appeared sufficiently striking to attract the notice of the historian. The beard of our own King Harry the VIII. has found its way into a ballad that appears to have been produced about the time of Charles I.:—

> "But, oh! let us tarry for the beard of King Harry,
> That grows about his chin,
> With its bushy pride, and a grove on each side,
> And a champion ground between."

From Gibbon we are taught to smile at the beard of the Emperor Julian, who based his claims to be ranked amongst philosophers upon the filthiness of his person, and the disgraceful condition of his beard. King Robert I. of France also had a remarkable beard, which, in the opinion of some, seems to have made him more renowned than his exploits. Indeed, his achievements were attributed in no small degree to his "long white beard, which he allowed to hang down on the outside of his cuirass to encourage his troops in battle, and rally them when defeated."

Perhaps this is not to be wondered at, for still there seems something of dignity about a beard, as is conveyed by many a mode of speech. Many a barefaced man, though nearly thirty, has been twitted as "beardless;" and we remember a story of a smooth-faced ambassador who was despatched to a certain king, who taunted the "*beardless* boy" as unsuited to deliberate upon grave affairs of State. The ambassador replied that if his master had known that his Majesty required a beard, he would have accredited a goat to his court. Old Fuller also has a word of comfort for those that have to face the world unfriended by a beard. "Beard," says he, "was never the true standard of of brains;" but it is plain some thought it was, or such a remark would have been totally unnecessary and out of place.

Amongst Asiatics the Persians have the finest beards. In former times Persian kings interwove the hair with gold thread, as may be seen in ancient sculptures, where their beards are stiff and matted, while those of common folk are simply curled. Even to-day "it is inconceivable," says Mr. Morier, "how careful the Persians are of this ornament." All the young men sigh for it, and grease their chins to hasten the growth of the hair; because until they have there a respectable covering, they are not supposed fit to have any place of trust.

Germany has perhaps yielded the most luxuriant beard on record. Its proprietor was Johann Mayo, a painter, commonly known as "John the Bearded." He was himself tall, yet when he stood up his beard reached the ground, so he usually wore it fastened to his girdle. To untie it and let the wind toss it in the faces of the lords of his court was a favourite pastime of the Emperor Charles V. Perhaps the most curious anecdote to be found in beard literature comes from Portugal. Juan de Castro, an admiral in the time of Catherine, Queen of

Portugal, had taken the Castle of Diu in India, but was sorely pressed for funds to maintain his fleet. The consequence was he cut off one of his whiskers and despatched it to Goa as security for 1,000 pistoles which he wished to borrow, with the message :—" All the gold in the world cannot equal the value of this natural ornament of my valour, which I deposit in your hands as a security for the money." The simple inhabitants of Goa, we read, were so much affected by this chivalrous sacrifice that they immediately sent back the money and the whisker.

The literature of beards is by no means meagre. From the very birth of civilisation almost up to our own time, a large share of men's attention has been given to this article. In Asia wars have been waged, and in Europe theological disputes of considerable warmth have arisen out of beards. So widely have these disputes ranged, and so capriciously do men's views upon the subject seem to have fluctuated, that it is impossible to seize clearly the chequered history of the barber's friend. Nowadays, the matter has ceased to trouble men's minds ; there are, however, many questions into which men enter with, perhaps, too much zeal, that in the light of future days will appear quite as frivolous as the question of beards.

SAILING ON SKATES.

In the winter time, when northern ports, such as the Baltic, are closed by ice, it is a very common thing for the sailors to pass the time in skating, or rather sailing upon skates. This pastime has a charm of its own unknown to the ordinary skater, and when practice has engendered confidence and dexterity in directing the sail, the proficient may bend backwards and, as it were, sleep upon the wind.

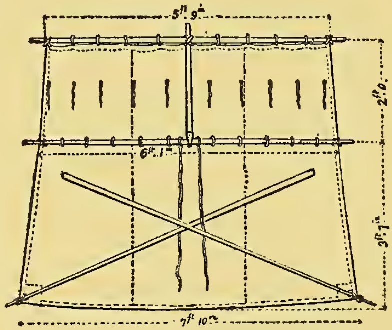


Fig. 1.

Fig. 1 is a representation of the sail used by Danish skaters and its dimensions in English measure. The material of which it is made, and the bamboo frame, are both very light ; so that the whole contrivance is no more trouble to carry than an umbrella. It is fastened round the body by a couple of straps crossed over the chest, and tied at the back of the body. The skater holds in his hands two rather large cross pieces of wood attached to the lower part of the frame, and adapted for directing the sail in any way that he may choose to go.

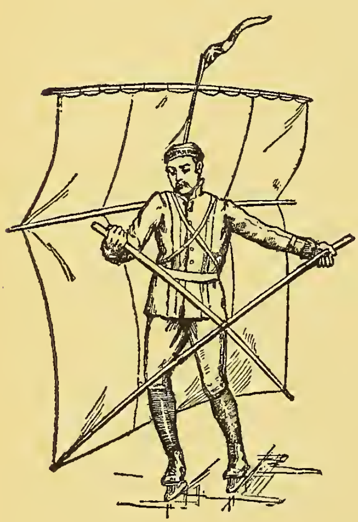


Fig. 3.

Fig. 2.

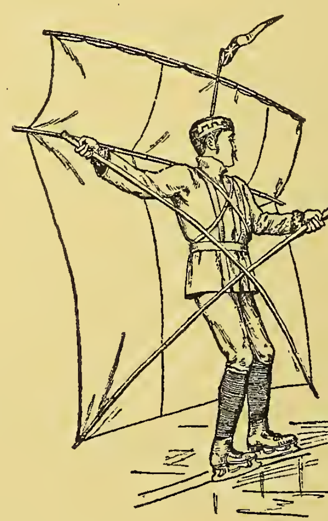


Fig. 4.

Fig. 2 shows the practised skater in full sail, skimming over the surface of the ice. Figs. 3 and 4 show him guiding his sail, and making progress, although not in the direction of the wind. When the wind is strong, it is necessary to lower the sail, which can be easily done, as in Fig. 5. When the skater wishes to go against the wind, the body must be bent forward, as in Fig. 6, so that the sail being horizontal, offers no resistance to the wind. The skater may thus return to the point whence he started and begin again.

This exercise is very agreeable, and not very dangerous; the falls made by a learner in practising at the beginning are not serious, as they generally take place backwards, and are thus modified by the sail. A considerable velocity may be attained by an experienced skater, though less than what certain ice-boats propelled by the wind often arrive at. After using the apparatus, it is taken

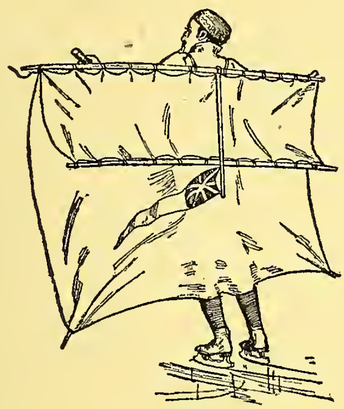


Fig. 5.

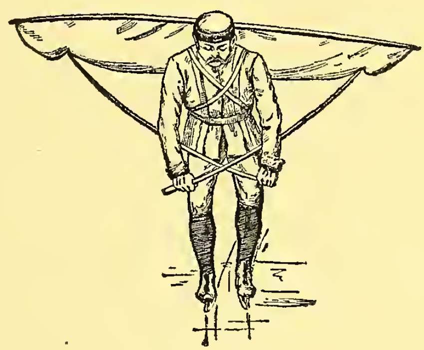


Fig. 6.

from the shoulders, the sail rolled round the bamboo sticks, and the entire concern is then no trouble at all to carry. When there is a good breeze blowing, it is by no means uncommon to meet groups of sail-skaters vieing with one another in speed. Expeditions with this apparatus are often made on the frozen sea between Denmark and Sweden, the Sound being entirely crossed in this way. The sail is refolded when the wind is contrary, and the skates used in the ordinary manner. Danish hunters in search of wild ducks and geese largely employ this means of locomotion, which is certainly worth being developed, even as a source of amusement.

The great obstacle, however, to the Englishman in the matter of skating is the want of ice. Our rivers flow on with the same liquid ripple in winter and summer alike, and are seldom seized by the icy king. The consequence is that we shall most likely continue to be permitted to enjoy the sweeping and semi-aërial flight of the inhabitant of the frozen north only in imagination. With the exhilarating effects of those games and exercises that are throughout the world so largely practised upon ice, the people of the southern part of Britain are acquainted in a very small degree. They are, however, not so badly off in this respect as the natives of climes that present the doubtful blessing of perpetual summer. Once upon a time, a missionary very much damaged his cause by using an ill-chosen illustration for the purpose of impressing the sluggish mind of the tropical heathen with the fact that there were wonders which he had never heard of and could not understand. "In my country," said the missionary, "the water becomes hard, and we can walk upon it." After that unfortunate statement the heathen would listen no more to the missionary, for he was convinced that the latter was only trying to deceive him.

ALCHEMY.

As astrology was the forerunner of astronomy, so was alchemy the forerunner of chemistry. Its origin has been traced by its different disciples back to the days of Adam, to those following the flood, to the time of Diocletian, to Job, to Noah, and to the ancient Egyptian monarch, Hermes Trismegistus, who, it is said, invented it. Pliny says the first alchemist was the Emperor Caligula. The earliest well-authenticated mention of alchemy is, however, a treatise on "The Divine Art of Making Gold," written by Zosimus, the Panopolite, who lived in the fifth century. This ancient MS. was preserved among the treasures of the royal library in France. The Romans denounced alchemy, and punished its professors. The golden age of alchemy existed amongst the Arabians. It spread with their conquests in Asia and Africa, and the superstitious Saracens practised it with implicit faith, firmly believing in its power to create gold, raise the dead, restore to the aged their youth, give the ugly beauty, and even, with the aid of certain herbs and cinders only, to create human beings! It was honoured throughout the entire world of

Mohammedanism, and amidst the power and magnificence of such courts as those of Alamanazor, Haroun-al-Raschid, and Abdallah Almammon, professors of the Hermetic arts held high rank and were rewarded with great wealth.

Geber, in the eighth century, whose real name was Abou Moussah Djafar, a native of Mesopotamia, is said to have written more than five hundred works upon the philosopher's stone, and the elixir, or water of life. He believed in a preparation of gold to cure all known diseases, and in the course of his experiments discovered corrosive sublimate, red oxide of mercury, nitric acid, and nitrate of silver, without which photography could never have attained its present perfection and popularity.

Alfarabi, in the tenth century, was not only a wonderful musician, but a famous alchemist, who devoted all his time and energies to discovering the philosopher's stone and the elixir of life. After writing many learned works on alchemy, he was murdered by some robbers in the year 954. Avicenna, whose real name was Ebn Cinna, Sultan Magdal Douleth's physician and Grand Vizier, wrote several treatises on alchemy before he died of premature old age and diseases created by debauchery, in 1036. The conquests of the barbarian Turks swept away alchemy from Egypt and Syria, to rest briefly at Constantinople, and be revived in the West.

In the twelfth and thirteenth centuries Albertus Magnus, Roger Bacon, and Raymond Lullius were famous alchemists, who interwove with its wild absurdities some valuable applications and discoveries of real permanent value. Many learned ecclesiastics, influenced by their example, became enthusiastic experimentalists, and Pope John XXII. asserted that by the aid of alchemy he had himself manufactured two hundred ingots of gold, each weighing one hundred pounds! Physicians practised the art with a view to discovering—as many asserted they had discovered—the great panacea, or universal medicine, whereby all diseases of whatever kind were to be immediately cured. Albertus Magnus, who had been, it was said, miraculously endowed with wisdom by the Virgin Mary, and was made Bishop of Ratisbon, was famous as an alchemist, and one of his pupils was Thomas Aquinas. The latter devoted his main efforts to the discovery of the philosopher's stone and elixir vitæ. He and his master, we are told, endowed a brazen statue with life to act as their servant, and Thomas is said to have destroyed it because, while performing its various duties, it made strange unpleasant clattering noises which disturbed him in his studies. Thomas strongly objected to noises. On another occasion, some grooms exercising their horses before his door so annoyed him by their shoutings and clatterings, that on their refusing to go away he invented a bronze magic horse, which so terrified the real steeds that they obstinately refused to come near it.

Raymond Lullius, a student of Arabic, became a follower of Geber, and devoted the latter part of his life to a search for the philosopher's stone. It is said that our first or second King Edward invited him to England, and that in the Tower of London he converted iron, quicksilver, lead, and pewter into gold valued at six millions. It was also said that he worked in Westminster Abbey, and that, in the cell he there occupied, long afterwards a great quantity of gold dust was discovered. Lullius states in his *Testamentum* that he converted fifty thousand pounds' weight of the baser metals into gold. Roger Bacon was another alchemist, who sought for the philosopher's stone with a firm belief in its existence and marvellous powers. Like Lullius, he was a man of great learning, and to him we owe some of the earliest discoveries in optical science as well as the discovery of gunpowder. His treatise on the "Admirable Power of Art and Nature in the Production of the Philosopher's Stone," and his "Mirror of Alchemy," have been translated into several languages.

Artephius wrote two famous treatises on the preservation of human life to an extraordinary length, and the philosopher's stone, in the thirteenth century. His disciples said he was Apollonius of Tyna, who lived soon after the advent of Jesus Christ; and he said at that time that he had reached the thousand and twenty-fifth year of his age! He also stated that in search of the philosopher's stone he had, by means of his magic art, descended into hell. Alain de Lisle, of Flanders, known as the "Universal Doctor," claimed the possession of the water of life, and Doctor Arnold de Villeneuve, who won immense fame as a physician, was supposed to have also won the power of converting lead and copper into gold. He narrowly escaped punishment as a sorcerer. His recipe for prolonging life to the extent of a few hundreds of years has been published, and here it is: First, you must rub yourself well two or three times a week with the juice of cassia. Each night you must place over your heart a plaster of Eastern saffron, red-rose leaves, sandal-wood, aloes, amber dissolved in oil of roses, and the best white wax. This is removed every morning, and preserved, for use on the following night, in a leaden box. You must then take sixteen chickens, if you are of a sanguine temperament, and twenty-five if you are lymphatic, and, having confined them where the air is perfectly pure, you must deprive them of all nourishment. When they are nearly starved you proceed to feed them with a mixture of wheat and bran steeped in a broth made of serpents and vinegar, giving them to drink water which is perfectly pure. This must be done for two months. In making broth for the chickens certain mystic ceremonies have to be observed. You eat one of these birds every day for sixteen or twenty-five days, drinking a moderate quantity of claret or other wine. If this diet, etc., is adopted once in every seven years, you may, it was said, attain the age of Methuselah!

Another eminent physician, Pietro of Apone, born in 1250, studied alchemy, and had the reputation of a magician. The money he paid away, however securely locked up, flew back to him, so it was said. The Inquisition seized him, and put him to the torture with such severity that he died before he could be tried. He was a personal friend of Raymond Lullius, and Pope John, already mentioned as a famous alchemist, was one of his pupils and admirers. The famous poet, Jean de Meung, was a well-known disciple of alchemy. Nicholas Flamel acquired the art from a book said to be written by the mighty Father Abraham himself in *the Latin tongue!* This book puzzled him half his life, but when eighty years of age he discovered a clue to its secrets whereby he was enabled to manufacture gold, and add five-and-twenty years to his span of life. Living meanly, and in apparent poverty, he certainly acquired great wealth, as the records of the hospitals and churches he endowed survive to show. He left behind him several works on alchemy; and a hundred years after his death there were those who refused to believe in it, and resolutely affirmed that he was still alive, and would be until he had attained his six hundredth year. In 1404, some rumour gaining ground of alchemists having found the philosopher's stone, an English Act of Parliament was passed declaring the manufacture of gold or silver felony. In support of this act it was urged that, supplied by alchemy with boundless wealth, any tyrannically-disposed monarch might readily enslave the country. Yet Henry VI. granted four successive patents and commissions to alchemists for their encouragement, as the patents say, "to the great benefit of the realm, and the enabling of the king to pay all debts of the crown in real gold and silver." This king also appointed a commission of ten learned and eminent men to investigate the possibility of making the precious metals.

George Ripley was famous as an alchemist in the fifteenth century. He was the Canon of Bridlington, in Yorkshire, and at one time the Pope's domestic chaplain. He dedicated one of his many works on alchemy to King Edward IV., and was popularly credited with the power of making gold. Amongst the most famous German alchemists were Basil Valentine, Prior of St. Peter at Erfurt, the Abbot of Trithemius, and Bernard of Trèves, the son of a physician, who wasted his entire life and large fortune in unavailing chemical experiments, reducing himself to beggary in his struggles after riches. His chief inspiration was found in the works of Rhazes and Geber, and at one time he was for three years incessantly occupied in his laboratory, eating, drinking, and sleeping in it. It is said that in his eighty-second year the labours of a long life were rewarded. He died at Rhodes in 1490, leaving several treatises on alchemy and chemistry. Trithemius, the son of a vine-grower of Trittheim, in Trèves, and Abbot of St. James in Wurzburg, where he died in 1516, was said to have made marvellous discoveries in alchemy, enabling him to create gold and raise the dead to life. From him comes the story of Dr. Faustus and the devil, for the truth of which he solemnly vouches. Gilles de Laval, Lord of Rays and a Marshal of France, attained fame as an alchemist in the fifteenth century. His wealth was enormous, and his love of display proportionately large. When poverty began to threaten him he resorted to alchemy, and, failing in it, to magic arts, in the pursuit of which murder on a wholesale scale was adopted, leading at last to his arrest, trial, and execution. The great merchant Jacques Cœur, into whose long purse the royal hand was so freely and frequently dipped, to be generously welcomed, and who attained boundless wealth with the utmost height of worldly power and grandeur, was popularly said to have made his position by alchemy, but there is very insufficient evidence to support the idea.

During the fourteenth, fifteenth, sixteenth, and seventeenth centuries, alchemists continued to play prominent parts, and to find both disciples and believers throughout Europe, encouraged by many monarchs, some of whom regarded an alchemist much as their predecessors had a wealthy Jew, subjecting him to prison and torture to compel him to supply the royal purse with gold. Numerous works on the subject continued to be written, and many men attained the widest fame as alchemists, the stories told of their magical doings remaining as incredibly absurd and strange as they had been in the earlier times. The eccentric Christina of Sweden listened not incredulously to the alchemists, and Frederick III. was their patron. Glauber, the inventor of the salts still bearing his name, established a school in Amsterdam for the study of alchemy, and lectured upon it. The Emperor Leopold of Austria was credulous enough to express his faith in it. Even in the eighteenth century cheats and pretenders continued to call themselves alchemists, and some infatuated self-deceivers still pursued its experiments. Nor has the present century been without its alchemy, one of the modern alchemists being Baron Cagniard de la Tour, if we may so call a chemist of genuine scientific acquirements, whose experiments on the real nature and construction of diamonds appear to the unlearned almost as wonderful as those which were intended to lay bare the tremendous secret of the philosopher's stone.

THE MICROPHONE AND ITS ALLIES.

THE invention of Bell's telephone opened a new chapter, both in the history of electricity and also in the science of acoustics. Its intense sensitiveness to very feeble sounds showed it at once to be not only an instrument for verbal communication between distant speakers, but indicated its usefulness as a detector of vibrations, which, without its aid, would be too feeble for appreciation. To Professor Hughes must be credited the greater part of the knowledge which has been gleaned since the invention of the telephone, respecting the connection between electricity and sound. In his hands the telephone has been made to reveal new secrets from the storehouse of nature; and instruments have been contrived by him to demonstrate the nature of his discoveries to others. To these new aids in investigation we will now direct our readers' attention, as one of the last and most important developments of electrical science.

It will be remembered that Bell's telephone works by virtue of a contained magnet, which induces currents of electricity in a coil of wire around it, which currents are varied in strength by the vibrations of a metallic diaphragm, set in motion by impact of sound-waves from the voice or other source. It is independent of any battery power whatever. Professor Hughes, by way of experiment, attached a weak battery cell to the telephone circuit in order to note the results. By keeping the attached telephone to his ear, the investigator was able to note, every time the connection with the battery was made good, a curious rasping sound come from the telephone. The same thing happened every time the battery was detached. By tightening the wire forming part of the circuit, by attaching a weight to it, and afterwards increasing that weight until the wire broke under the tensile strain, it was found that the telephone gave forth a grating sound just before the wire snapped, just as if the fibres of the wire were separated, and grated over one another before giving way. Such a dragging apart of the fibres would cause a variation in the electrical resistance of the wire, and such variation is audibly proclaimed by the highly sensitive telephone attached.

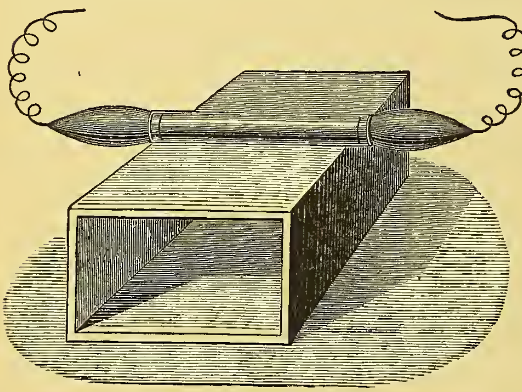


Fig. 1.—TUBE FILLED WITH METAL FILINGS.

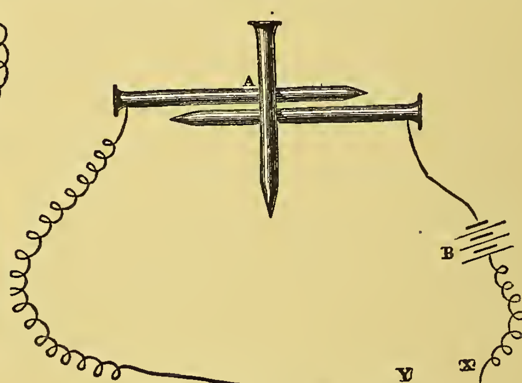


Fig. 2.—SOUND TRANSMITTED BY NAILS.

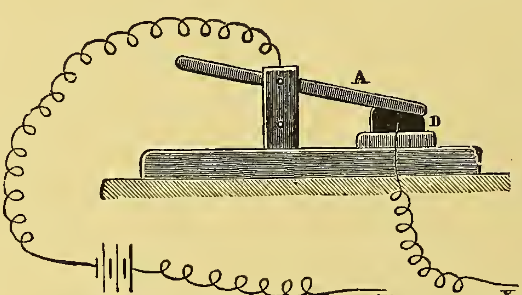
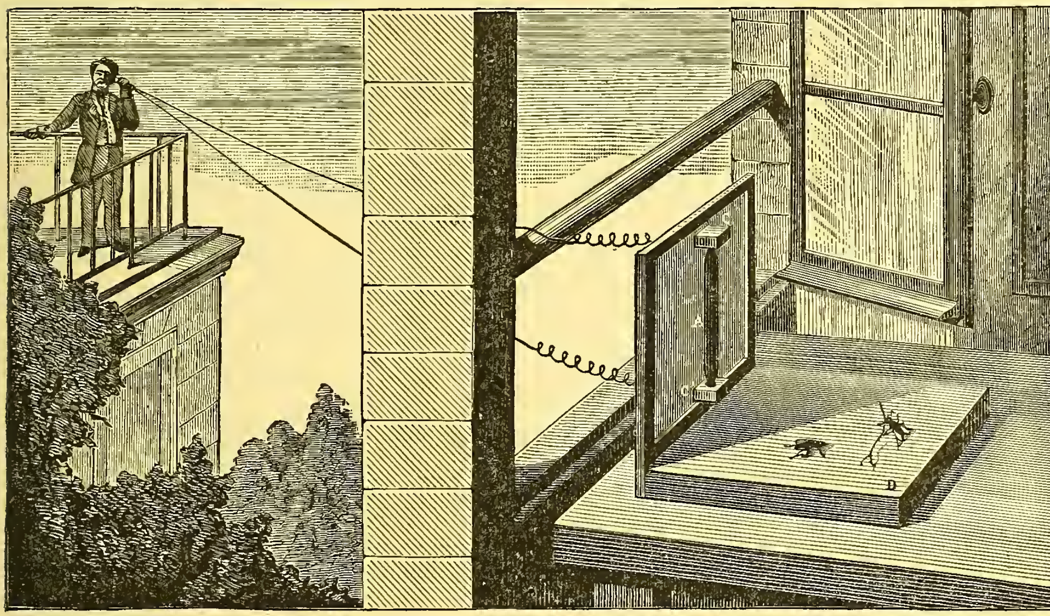


Fig. 3.—SIMPLE MICROPHONE.

An interesting experiment which bears upon this view of the phenomena has been arranged by Professor Hughes. A glass tube, about three inches long, is plugged at each end with pointed pieces of carbon, which are kept in their places by sealing-wax. The space between these two plugs is filled with metallic particles, a mixture of tin and zinc. To the carbon points are fastened wires in connection with a battery and galvanometer, the whole forming a closed circuit. Upon taking the glass tube between the two hands, and pulling upon it lengthwise—as if one would try to pull it in half—the needle of the galvanometer is deflected in such a way as to indicate that the current is decreased. By the opposite action of pressing the two ends together, the needle is deflected in the opposite direction, the current being increased by bringing the metallic particles, by this compression, into more intimate connection. Thus the tiny increment which a glass tube can sustain by the mere pull of the fingers is manifested. By mounting the same simple arrangement on a resonance box—as in Fig. 1.—it is found that sonorous vibrations can be taken up by it, and that it will act in every way as an efficient transmitter of vocal and other sounds. The shaking caused by the sounds, brings the particles into periodically closer or looser contact, and thus acts like the stretching or compression of the glass tube. The same end can be accomplished by taking a slip of charcoal, such as artists use for rough sketches, and after heating it to redness, plunging it into a bath of mercury. By this treatment its pores become filled with metal in a state of fine division, and it will act as a transmitter nearly as well as the tube just described.

Even the simplest mechanical arrangements will give much the same results, provided that they exhibit loose points of junction. Thus a chain placed in a little heap will answer admirably. But perhaps the simplest arrangement of all, is that shown at Fig. 2. Two French nails, A, are fastened or laid upon a flat surface, their heads being connected with a battery, B, and telephone, by the wires X and Y. A third nail is laid across the others, forming a bridge between them with two very loose contacts. Strange as it may seem, this simple contrivance will take up sonorous vibrations, and will make them loudly manifest in the attached telephone, even though that telephone be placed at a great distance away. More perfect results are, however, to be gained from the form of instrument shown at Fig. 3, which is still so simple that any child could make it. A base-board about three inches long, has fastened to it a little block of carbon, D. From this block a wire, X, passes to a telephone. Also on the base-board, but more towards its centre, is a U-shaped piece of brass plate, and hung in its embrace is a pencil of carbon, its lower end touching the block D. From the U-piece proceeds the wire Y, passing to the battery B, and finally closing the circuit at the telephone, Y. To this instrument, in its various forms, Professor Hughes has given the name of microphone, since it acts not only as a detector of minute sounds, but as a magnifier of them. Indeed, it may be said that it does for the ear what the microscope does for the eye. Sounds which otherwise would be completely inaudible are rendered so loudly as to at once attract attention to them. With the microphone shown at Fig. 3, the writer has been able to magnify the rustle of a feather to such an extent, that an audience of several hundred people have plainly heard its movement. In that particular case the telephone was attached to a support, and was furnished with a long cardboard-trumpet mouth. The feather of a quill pen was



THE MICROPHONE TRANSMITTING SOUND OF A FLY'S FOOTSTEP.

then lightly drawn against the block D, with the result stated.

Another form of microphone is that shown at Fig. 4, where two pieces of wood are fastened together, so that one stands vertically. Upon the vertical piece is seen the microphone, consisting of two little hollowed-out pieces of carbon, C, with a pencil of the same material, A, loosely resting between them, and forming the necessary imperfect junctions. Upon the platform represented by the other piece of wood, D, a watch or clock can be placed, and every movement of its mechanism will be plainly heard in the attached telephone. In the illustration an individual in another building is seen listening to the footfalls of a couple of flies which are walking across the instrument. For the sake of clearness, the experiment is shown thus, and the microphone is for the same reason much exaggerated in size. In actual fact the carbon rod need not measure more than one inch in length, and the flies are conveniently confined within a match-box furnished with a muslin top.

In a paper read by Professor Hughes before the Royal Society, he thus accounts for the action of the microphone :—"It is quite evident that these effects are due to a difference of pressure at the different points of contact, and that they are dependent for the perfection of action upon the number of these points of contact. Moreover, they are not dependent upon any apparent difference in the bodies in contact, but the same body in a state of minute subdivision is equally effective. . . . . Molecular action alone explains to me all the effects produced. Size or shape does not affect them. A piece of willow-charcoal the size of a pin's head is quite sufficient to reproduce articulate speech. I regard the action as follows : If we have two separate conductors joined simply by contact, this contact offers a certain resistance. Now, we can vary or lessen the resistance by increasing the pressure, thus bringing more points in contact or closer proximity."

Fig. 5.—SEARCHING FOR A HIDDEN BULLET BY THE INDUCTION BALANCE.

There are some people who will fail to appreciate a discovery such as that of the microphone, unless it is shown that some practical advantage is derivable from it. In answer to the inquiry whether the microphone is anything more than an ingenious and very interesting toy, we may state that it already forms the transmitting agent in various systems of telephony. Another application of the microphone is its association with an instrument also contrived by Professor Hughes, and called the induction balance. To understand its action we must invite the reader's attention to Fig. 5, which illustrates its use in pointing out the position of a bullet which the probe has failed to discover. It will be remembered that the induction balance was thus used at the sick-bed of the late President Garfield.

The instrument consists essentially of two distinct circuits, one of which acts inductively upon the other. In the picture before us, the telephone held to the surgeon's ear is connected with two coils placed upon wooden drums, one of which is seen on the table, and the other is in the operator's hand. At the lower part of these drums are two similar coils quite distinct from the others ; and in circuit with them is a clock, giving almost imperceptible ticks, a microphone, and a battery cell. The latter stands on the table, while the clock and microphone are on a shelf above it. Now the coils are so wound on their drums, and otherwise adjusted, that so long as they remain as they are, the current flowing in one coil is exactly neutralised by a contrary current flowing in the other coil, so that, normally, the tick of the clock is unheard in the telephone. But suppose that the coil below the operator's hand be moved near a coin, a bullet, or any metallic mass, this balance is at once destroyed, since part of the inductive action is now employed in setting up currents in the coin or bullet, as the case may be. The balance of the currents is thus disturbed, and the overplus suffices to work the microphone, and so make audible the ticking of the clock. The surgeon, therefore, shifts the coil from place to place until he hears the tick of the clock in the telephone, and by carefully noting the intensity of the sound he is soon able to indicate the exact position of the bullet. Another application of the induction balance is known as the audiometer. This instrument is used for testing persons' hearing, and is likely to prove of immense service in diagnosing cases of partial deafness.

In all these instruments it will have been noticed that sound has been transmitted by causing its vibrations, in some way, to periodically *vary the resistance* of an electric current. The last and most wonderful application of this process is in the *photophone*, by which a beam of sun-light is made the medium of conveyance, in a manner now easily understood. There is a chemical element called Selenium, whose electrical resistance varies enormously, according as it is exposed to light or not, and with enormous rapidity also. A "selenium cell" is therefore formed of alternate layers of selenium and metal, which comprises the microphonic part of the circuit. The transmitter is a very thin film of mica or glass silvered, the front of which reflects a sun-beam, and towards the back side of which is fixed a mouthpiece. When this is spoken or sung into, the silvered face is made to vibrate, and the reflected beam of sunlight of course *varies* in intensity as the mirror is convex, concave, flat, or varied in surface. The operation will now be readily understood from Fig. 6. A beam of sun-light is reflected from a heliostat-mirror, M, into the instrument. A lens, L, condenses it, and an alum-cell, C, filters out heat which might complicate the effects ; and the beam then falls on the silvered mica, D, "spoken to" by the mouthpiece, O. The beam thus varied in intensity by the sound-vibrations is made nearly parallel by a second lens, L^2, and so reaches the parabolic reflector, R, which brings the light nearly to a focus on the selenium cell, P. This is joined up with the battery, B, and Bell telephone, T. The effects follow virtually as before. The sunlight, rapidly varied in intensity by the transmitter,

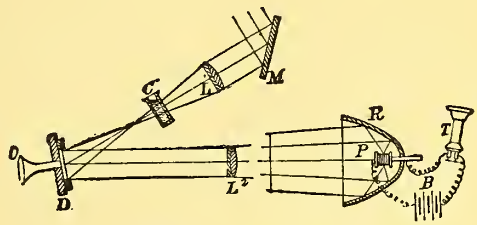


Fig. 6.—THE PHOTOPHONE.

D, falling on the selenium-cell, P, causes the electric resistance of this cell to vary as the light of the reflected beam varies ; and this variation in resistance is sufficiently rapid to reproduce the words. Speech has been thus carried upon a sunbeam for a distance of 700 feet. While the photophone, however, must be pronounced one of the most wonderful and interesting discoveries of all from the scientific point of view, it is perhaps doubtful whether it will be of any great utility, from the difficulty of reflecting light with sufficient intensity to any very great distance. Should this difficulty, however, be overcome in any way, its utility as a signalling apparatus is too obvious to need remark.

A SINGULAR COINCIDENCE.

On December 5th, in 1664, a boat crossing the Menai Strait was sunk with eighty-one passengers on board. Only one escaped, and his name was Hugh Williams. On December 5th, 1785, another boat was sunk under the same circumstances. It had sixty passengers on board, and all were lost except *one*. *His* name was Hugh Williams. On the 5th of August, 1820, the *Bristol Mercury* records another such accident. There were at that time twenty-five passengers on board. Only *one* escaped, and, wonderful to tell, *his* name was Hugh Williams. We may add, however, that the name is a very common one in Wales and amongst people of Welsh descent.

SPECTRE BEETLES.

AMONGST the wonders of the insect tribes, the curious Spectre, or Leaf Beetles, of the East Indies (*Mormolyce phyllodes*) depicted in the accompanying engraving, appear as highly prominent figures. The appearance of one of these insects is weird and fantastic in the extreme; and their history likewise partakes of much that is curious and interesting. They were first made known to European science about 1820. It was then that Kuhl and Van Hasselt sent them to the museum at Leyden; and in 1825 they were figured in a memoir of Hagenbach's. Formerly they were esteemed so rare, that specimens have been sold for a sum of £50, or even more; but with increased facilities of travel and research, their value has decreased with the increased number of specimens which have been obtained. Again, through the efforts of collectors, the area known to be inhabited by these creatures has been much enlarged. Formerly they were believed to be confined to the Eastern Archipelago, and indeed, the species figured is found in Java, Borneo, and Malacca. But allied forms occur throughout the Archipelago, and in Eastern Asia generally; and the family has its allies in many insects inhabiting the latter region.

These insects and their neighbours are notable for a feature well shown in our illustration, namely, the curious form of he *elytra*, or wing-covers, which in the beetle tribes are formed by the first pair of wings, which, being thus useless for flight, become utilised as protective covers for the hinder and useful pair. The margins of the wing-covers in the *Mormolyces* are thus seen to be expanded and flattened out, and the animal appears under a somewhat leaf-like guise—a feature which has given origin to the term *phyllodes*, applied to the species. Hence these beetles are allied to some of the remarkable Stick and Leaf Insects which have been described in previous articles. The head, as is also shown in the figure, is joined to the chest by an elongated "neck," and the eyes are large and prominent; whilst the "feelers" well nigh extend the length of the body itself. The first segment of the chest has a toothed edge on either side. The inhabitants of Java call the insect by the name of the "viol," since they not only recognise in the form some resemblance to a musical instrument, but believe it to be also capable of producing independent sounds.

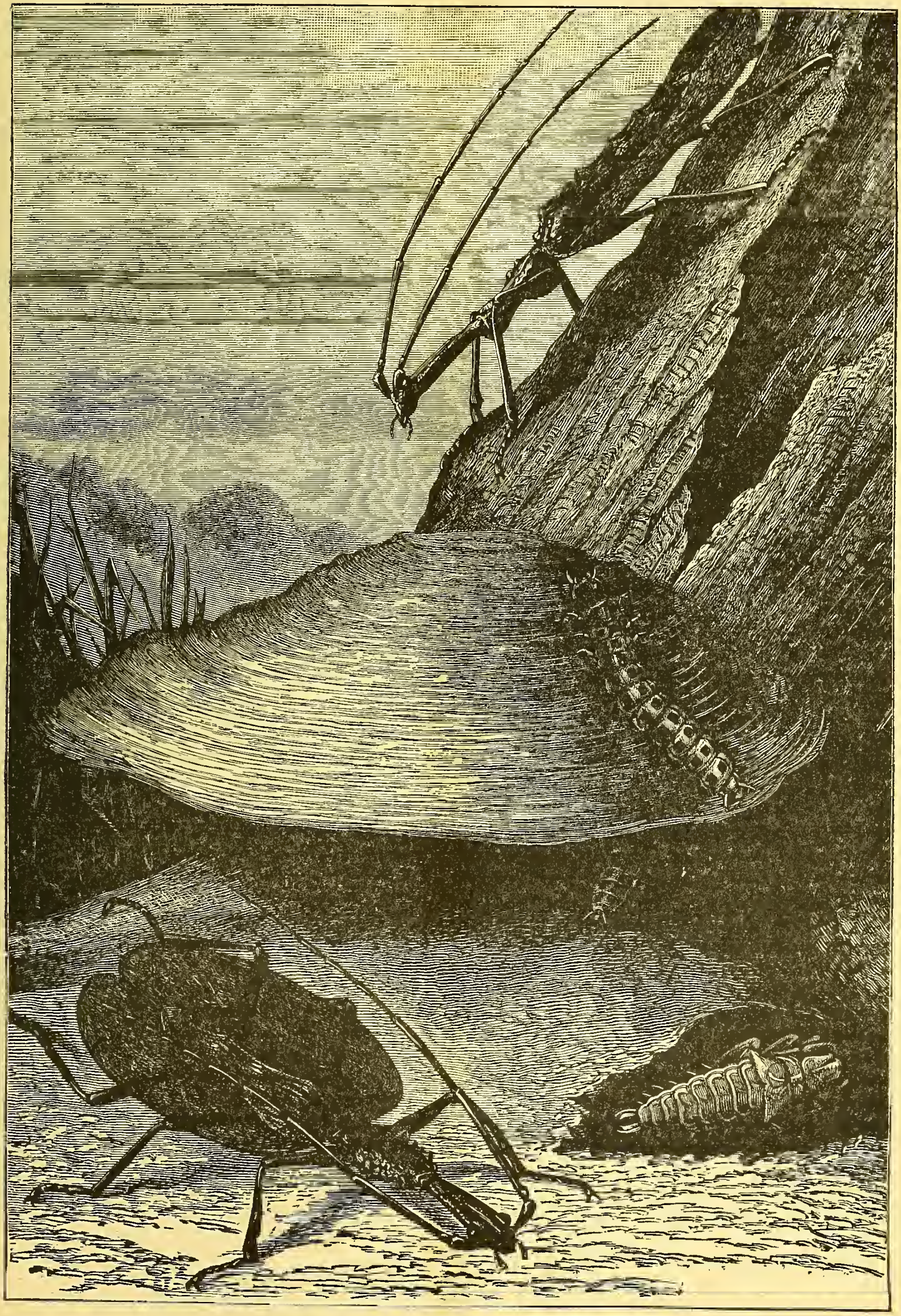
The natural habitation of these insects is in the forests of the tropics, where, under the bark of, or the moss growing on, trees, they conceal themselves by day. Their appearance as they rest on the trees, serves as a kind of "mimicry" concealing them from the observer. They are also extremely agile in their movements, and appear to burrow or to force their way with great agility beneath the bark of the trees when disturbed or alarmed. Like all the beetles, the *Mormolyces* undergo a perfect "metamorphosis." As in the butterflies, there are three stages included in this process—namely, *larva*, "chrysalis" or *pupa*, and the "*imago*," or perfect insect. The *larva*, or caterpillar-stage of the *Mormolyce*, is well-marked, as shown in our figure. It is of a brown colour marked with darker orange spots. In from eight to nine months the larva becomes transformed into the chrysalis, or pupa stage, in which the insect is quiescent, usually occupying a hole in the ground, or some similar situation. From this stage the perfect insect in due time emerges, all its characters being outlined as the chrysalis form gives place to the final and complete stage of its existence.

According to one observer, these insects unite offensive powers to their strange forms. It is said that they secrete a strangely irritating corrosive liquid, such as disables for a space of time the fingers of the person who unwarily seizes them. But it is probable that this latter observation should be received with caution. In the dead and preserved shape, at least, no traces of such offensive powers remain.

OSTRICH STOMACHS.

DR. BOEHMEN, of Wittenberg, described a man who on one occasion ate a raw sheep, a sucking-pig, and by way of dessert sixty pounds of prunes without ejecting the stones; and on another devoured two bushels of cherries, several earthen vessels, and chips from a furnace. He also ate at the same time, some pieces of glass, pebbles, a shepherd's bagpipe, rats, birds with their feathers, and an incredible number of caterpillars, finishing his astonishing meal by swallowing a pewter ink-stand, with its pens, pen-knife, and sand-box. The doctor also informs us that during this miraculous deglutition he was generally under the influence of brandy, but appeared to relish his strange food, and was a man of extraordinary muscular strength, who died in his seventy-ninth year! Helwig says he knew an old man whose daily supply of food weighed eighty pounds! Real Colomb mentions a gluttonous fellow, who, being very hungry, once devoured a sack of charcoal and the sack!

In 1632 it is on record that a Lorrainer, named Claudius, a man of low stature and very thin, used frequently to swallow with impunity glass, stones, pieces of wood, hares' feet, hay, straw, and other strange articles, pieces of linen and woollen fabrics, and small living animals, including on one occasion a couple of mice. The great philosopher of the seventeenth century, Robert Boyle, mentioned



THE MORMOLYCE PHYLLODES AND ITS METAMORPHOSES (*Natural size*).

at the Royal Society an English soldier who used to eat stones, and a man named Lazarus who used to eat glass.

It is recorded of an official at the Botanical Gardens in Paris, named Bijou, that in one day he ate a dead lion. On opening the body of a convict at Brest, the surgeon found in his stomach about six hundred pieces of wood, pewter, and iron.

Several eminent physicians and other persons have given us the history of a man named Tarre, who was employed by a travelling quack as his clown, after the fashion of his day. He swallowed with ease corks, pebbles, and large quantities of apples. He afterwards became a soldier. In the presence of Dr. Lorentz, this monster tore open a live cat, sucked its blood, and devoured it. He would take living snakes, and eat them in the same disgusting way, grinding their heads between his teeth. Mr. Courville, a surgeon, once gave him a wooden lancet-case to swallow, round which had been placed a written paper. This experiment was made with the idea of employing him to convey secret information in this way. It succeeded. While so engaged, he was detected by the Prussians, and punished as a spy. He died in his twenty-sixth year in the hospital at Versailles.

Apart from the feats of sword-swallowing performed by itinerant jugglers, and similar feats by which the spectators are deceived, there exist properly authenticated and very extraordinary cases of persons who have actually eaten knives, and paid the penalty of such a diet. In the *Edinburgh Philosophical Journal* a remarkable case is discussed: that of John Cummings, an American sailor, who swallowed at different times within the space of a few years as many as thirty clasp-knives. It seems that when he was twenty-three years of age, being ashore with other sailors, about two miles from Havre de Grace, he witnessed the feats of a conjuror who pretended to swallow knives. When on board his ship, and drunk, he swore he could swallow knives as easily as the Frenchman did, and being challenged, he took his own knife, and contrived to swallow it, as he said, easily. He afterwards offered to swallow all the knives they could bring him, and did in fact swallow three. This feat, for the entertainment of different parties, he often performed afterwards, and in March, 1805, being in Boston, he swallowed on one evening and the following morning no fewer than fourteen knives, after which he was so seriously ill that he had to be taken to Charlestown Hospital. Being some time afterwards taken with others—probably for carrying on some illicit traffic—by the officers of his English Majesty's ship the *Isis*, again while drunk, on the 4th December in the above-named year, he swallowed twelve clasp-knives, and these terminated his career, after a long and terrible illness resulting from their presence. He died in March, 1809, in extreme agony, under the care of Dr. Babington, of Guy's Hospital, in the records of which the case appears with all its details. He was thrice admitted to the institution and twice discharged, and on his first appearance there the doctors refused to believe his extraordinary story of knife-swallowing.

In the same scientific journal another case of knife-eating is recorded by Dr. Barnes, a physician of Carlisle: that of a professed juggler, named William Dempster. This young man swallowed a knife by accident while exhibiting in a small tavern in Botchergate, in November, 1823. The weapon was nine inches in length, and he was terribly alarmed, thinking it would surely kill him. Medical assistance was at once procured, but no efforts could recover the knife through the mouth, and he was long under treatment, during which time the extraordinary nature of the case attracted a great number of surgeons and physicians to his bedside. It was submitted to two of the most eminent men of that day, Sir Astley Cooper, of London, and Mr. George Bell, of Edinburgh. A report of the Carlisle Dispensary says: "The surgeons of the dispensary were unanimously agreed as to the best mode of treating this extraordinary case; they were of opinion that nothing but an operation could save the patient's life, but he could not be persuaded to submit to it." He left the hospital on December 28th to return to his home in London, contrary to the advice of the surgeons, who considered the act a fatal one—as, indeed, it proved, for he died on his road, at Middlewick, in Cheshire, on January 16th, inflammation and gangrene of the stomach having been produced by the irritation of the knife and the jolting of the waggon.

Dr. J. G. Millingen mentions a man who died in a public-house, the examination of whose stomach and intestines resulted in the discovery of several clasp-knives, with their blades blunted and their handles consumed. He was probably killed by these strange articles of food.

Another similar case is described by Dr. Daniel Beckher, of Dantzic, in Leyden, as occurring in 1836, in which the knife was extracted by an operation, and the patient recovered. Other cases of more recent occurrence might be cited, but their details do not differ in any important particular from those already given.

Sword-swallowing differs from knife-eating, inasmuch as nothing is permanently introduced into the stomach, but is none the less marvellous. Early conjurors appear sometimes to have used collapsible or telescopic swords; but later performers undoubtedly possessed the power of introducing a solid blade down the gullet into the interior of the body. A sword-swallower who exhibited in London in 1881 was carefully examined by many medical men, and the general opinion was that the end of the sword pushed down the farther side of the stomach as if it were an elastic bag. A still more recent performer, named Frederick Smith, met with a serious accident in the spring of 1883. While swallowing a sword it became embedded in the gullet, and he by motions requested one of the audience to withdraw the weapon. The man thus appealed to placed his hand on the hilt, causing the blade to penetrate the intestines, and the juggler was removed to St. Thomas' Hospital, where he was for a considerable time in a very dangerous condition.

PULSE RECORDS.

IN the year 1616 Harvey made that grand discovery of the nature of the circulation of the blood, which has made his name famous. Before his time the science of Physiology, as we now understand it, was unknown; but this famous discovery was its foundation-stone, upon which, bit by bit, the modern science has been erected. True it is that before Harvey's time isolated facts had been observed and noted, and this is a feature of nearly every important discovery; but these facts remained for many years lying idle, like independent links, waiting for a master-mind to forge them together in a connected chain. At that time so-called physicians, who were often astrologers as well, relied more upon the influence of the stars, or upon the use of certain herbs and simples, than upon any knowledge of physiology, which, indeed, was impossible until the phenomena surrounding the circulation of the blood were demonstrated and understood.

Long before Harvey's time it was known that the body contained two kinds of vessels—arteries and veins. The first, as implied by their name, were believed to be in communication with the air-passages, and to contain air. By a few simple experiments, Harvey showed the fallacy of this idea. He proved that the heart was a kind of pump, receiving the blood from the veins and discharging it by the contractile power of its ventricles through the arteries, to be ultimately carried all over the body. Harvey's theory was accepted, but it was reserved to others to actually see the blood in circulation, as Malpighi did in 1661; and as we can any of us do now by watching the transparent webbing of a frog's foot beneath the microscope.

In all warm-blooded creatures the heart is a double organ, having right and left sides entirely distinct from one another, but acting simultaneously. It is the duty of the right side to receive the blood from the veins, and to send it to the lungs, where it may be re-vivified by the action of the air taken in with every breath. The left side receives the freshened fluid, and transmits it by the arteries through the system. (See "Wonders of the Heart," p. 29). This circulatory system is kept up by the contractile power of the ventricles, which pump the fluid blood through its various channels. It is not a matter for surprise that this pumping action should cause an impulse to be carried through the various arteries, an impulse which can be felt if the finger be applied to an artery lying near the surface of the body. By a simple experiment, this pulse—as it is now universally called—can be made to reveal itself as a movement of the body. Let the subject of the experiment sit down, and cross one leg over the other, so that one knee is exactly below the other one. The pressure caused by the weight of the upper limb upon a certain artery will cause that limb to excute a slight movement up and down with every beat of the heart. It is quite possible that some such experiment as this suggested the thought that, by suitable mechanical attachments, the pulse might be able to record graphically its own movements. That this has been done in a remarkably successful manner is evidenced by that clever little contrivance, to be presently described, called the sphygmograph.

Doctors attach much importance to the frequency and general condition of the heart's action; hence their first operation upon seeing a patient is to feel his pulse, and to time its rate by their watch. In the human adult, the pulse gives normally about 70 beats per minute, in the female from 76 to 80 beats, and in the child considerably more. It will be readily comprehended that a movement occupying only the seventieth part of a minute will not allow of close study. So that experiments on the pulse have formerly been performed upon some cold-blooded creature—such as the frog, for instance—where the rate of movement, being only from 10 to 20 per minute, gives time for more extended observation. But in feeling the pulse the doctor does not alone note its frequency. He judges of the state of health quite as much by its nature, and will speak professionally of "a soft and compressible pulse, a wiry pulse, a hard pulse, a weak or a strong pulse," &c., as describing in a manner, perfectly understood to himself and his brethren, various conditions of the circulatory system. It is evident that if such variations can be graphically recorded—photographs, so to speak, of an unseen thing—such records must be of immense service. The sphygmograph has been designed to accomplish this result.

The first instrument of the kind was produced by Vierordt, but it was most complex in construction, and bears the same relation to a modern sphygmograph as does one of the old matchlocks to a modern rifle. The movements of the pulse were, by means of a lever, transmitted to a point which scratched a trace upon a revolving cylinder covered with blackened paper. But such trace was merely an up and down mark, representing only the amplitude of the beat. In principle its construction was correct, but as an indicator of the state of the circulation it was valueless. Other workers improved upon it, with the important aims, among other considerations, of making it more simple and compact, and more easy of application. Instead of the simple up and down movement, an instrument was required which would note the various shades of dilatation and contraction of the vessels, and these conditions were eventually fully realised in the sphygmograph of M. Marey, illustrated in action at Fig. 1.

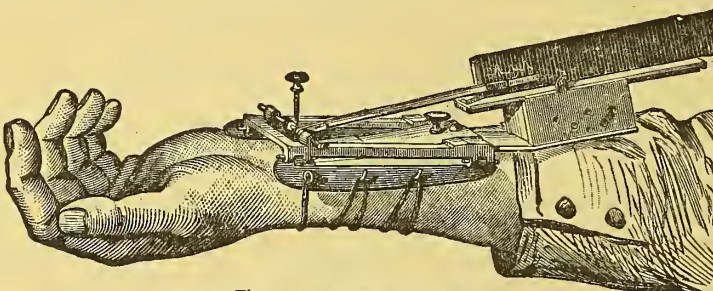


Fig. 1.—THE SPHYGMOGRAPH.

This modern form of sphygmograph is, it will be noticed, quite self-contained, and is readily attached to the patient's wrist. A little adjustable pad, pressing upon the artery, causes a light lever to rise and fall with every beat of the pulse. This lever has at its end a point which touches a blackened card. By a simple contrivance, this card is caused to travel from right to left, and as it does so the lever, or style, draws upon it a graphic trace, giving far more information than could be obtained by simply feeling the pulse in the ordinary manner. In Fig. 2 is given a set of these traces, a detailed description of which would only interest the professional reader; but a cursory glance at them will show what vast differences exist in the tracings furnished by different subjects. To one point alone we will call the reader's attention. The pulse does not in any case show a simple up and down record. First, there is an elevation of the lever caused by a dilatation; this is more or less sudden, as indicated by the angle of the trace. Now follows a contraction, interrupted by a second elevation, slighter by far than the first. This second impulse is sometimes, but rarely, capable of appreciation by the finger; but when it can be detected it gives the idea of a double pulse. It is caused by an oscillation of the fluid contents of the vessels between the contractions of the heart. These various movements have been studied experimentally by M. Marey, by the aid of a simple apparatus to represent the fluid contents of the ventricles and attached vessels. With india-rubber bags to represent the former, and tubes of the same material to represent the latter—both filled with water—M. Marey was enabled to reproduce the movements artificially.

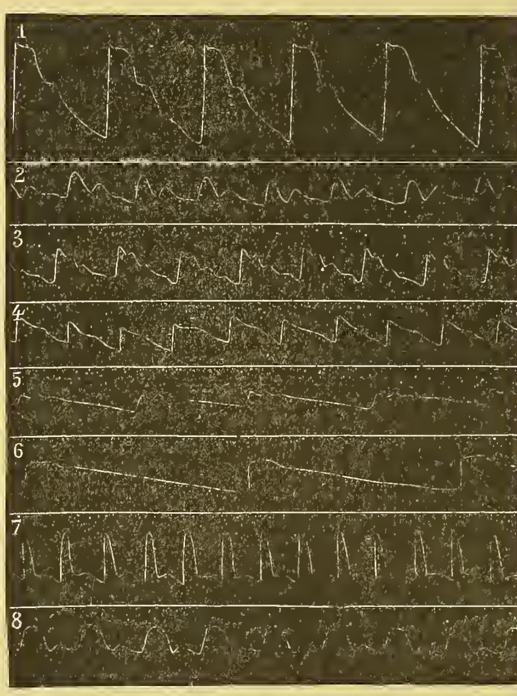


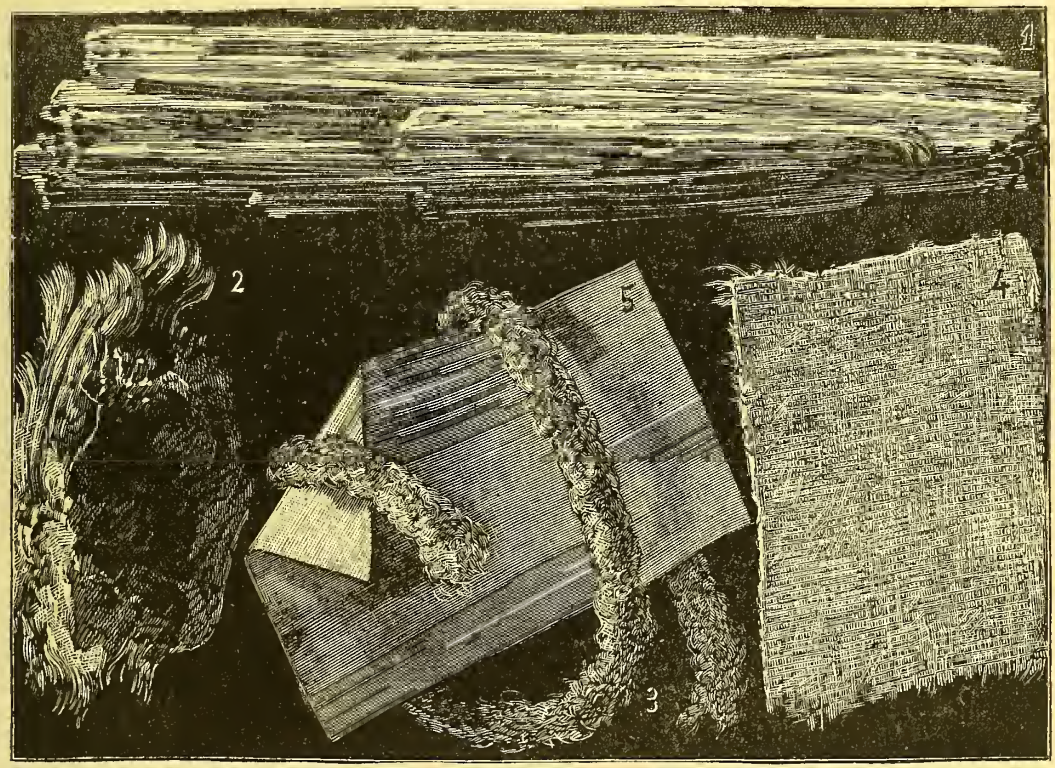
Fig. 2.—PULSE TRACINGS.

We may mention in this connection the recent invention of an instrument somewhat like the sphygmograph, but having attached to it a microphone. By means of this contrivance the beatings of the pulse can be *heard*. The sounds given are loud enough to fill a large room, and are so characteristic that the state of a person's heart can be readily diagnosed by the experienced ear. This modification of the pulse-recorder is known as the sphygmophone.

ASBESTOS.

OF all the disasters to which human nature is heir, there is none which is so much dreaded, and which inspires so much horror, as accidents or death by fire. In all well-regulated public buildings, precautions against fire are the first things to be considered, and since the recent occurrence of vast conflagrations, in which the victims have been numbered by hundreds—not, happily, in this country—our authorities have been very careful to see that the regulations made for public protection are rigidly enforced. Unfortunately, most substances which are in common use are combustible, and even those which we usually look upon as being fireproof, are melted and destroyed in the heat of a fierce conflagration. We have buildings of recent date which are called fireproof, but when we come to examine them, we find that their necessary internal fittings and furniture would burn like matchwood ; indeed, a really fireproof building is—if it be fitted for occupation—almost an impossibility.

There is one substance, however, which seems to resist all attempts at destruction by fire, and that is the curious fibrous material asbestos, which takes its name from a Greek word, signifying incombustible. Examined chemically, it is found to consist chiefly of silica, magnesia, alumina, and oxide of iron ; and is a variety of that group of minerals, of which hornblende is the type. Originally thought to be scarce, it is now found to be plentiful in many parts of Europe and America ; the modern demand for it quickly meeting with a sufficient supply. But although the substance has only of recent years been introduced commercially, it was not unknown to the ancients. Among those nations whose practice it was to burn their dead, asbestos was used to separate the ashes of the departed from the coarser and valueless products of the funeral pile. Still later tradition asserts that Charlemagne had a table-cloth woven of asbestos, and astonished his guests by cleansing it in their presence, by throwing it upon the fire.



ASBESTOS AND ITS MANUFACTURES.

The finest asbestos comes from America, and its quality is determined by the length and strength of the fibres which can be separated from it, and the fineness of that fibre. A piece measuring only two or three inches square, can by careful manipulation be made to fill a half bushel measure with what appears to be the finest wool. It is this similarity to wool that allows it to be woven into cloths, ropes, felted and matted fabrics. Our illustration depicts it in its natural state, and in some of its manufactured forms. Fig. 1 is a specimen of Canadian asbestos in its raw state; 2, is Italian asbestos. In Fig. 3, we find it manufactured into rope; 4, into cloth; and 5, gives us a sample of asbestos paper.

It is little more than twenty years since the varied uses to which asbestos could be put first attracted attention. From that time to the present, its applications have been gradually extended, until now it is manufactured into all kinds of different forms, and is used for many different purposes. In the form of felt it can be placed between a ceiling and the floor above, so as to prevent the spread of fire. In the form of a closely woven cloth, it can also be used as a safeguard against fire. Asbestos rope of loose texture is now largely used as a packing for the pistons of steam-engines, whilst rope of stronger make can be applied to fire-escapes, or can be used in theatres, or in other buildings where the fire risk is great. As a non-conducting covering for steam-boilers, asbestos also holds a foremost place; while it enters very largely into the composition of cements of a fireproof and effective character. Asbestos millboard is used for a roofing which is both waterproof and fireproof; in another form, the material finds a place in the chemist's laboratory, where it is used for filtering acids, and other compounds, which would quickly destroy ordinary media.

The latest, and perhaps the most interesting, application of asbestos, is in the manufacture of a fireproof paint, which seems, from recent public experiments, to fulfil its purpose in the most admirable manner. This paint, while not more expensive than the ordinary white lead compounds, weighs very much less, and has better covering power. It will resist the action of sulphuretted hydrogen and other gases, and is therefore well adapted for railway bridges, and other structures of the kind. But its fireproof quality is its most important feature, and renders it specially valuable for painting joists, rafters, beams, stairs, and, indeed, any wooden structures whatever.

The first important trial of the asbestos paint took place in 1882 in the grounds of the Crystal Palace, Sydenham, before a representative assemblage, which included the managers of several of our theatres and other public buildings. The first experiment consisted in igniting some cotton, linen, and gauze fabrics, which had been partially treated with the paint. The unprotected portions were quickly reduced to tinder, whilst those to which asbestos had been applied remained intact. Next, upon a fierce fire were thrown some blocks of wood, some painted, and some unpainted. The latter were quickly inflamed, but the painted blocks resisted the action of the fire even after blisters had been raised on their surfaces. The bursting of these blisters allowed the heat to get to the wood underneath, which was charred, although the painted shell remained unaffected. The concluding experiment was on a far larger scale, and gave a better idea of the real value of the invention. Four timber erections had been built up, two of them being about 12 feet wide, by 8 feet deep, and 10 feet high, and made to resemble theatrical stages, fitted with ropes, curtains, scenery, and effects all complete. One of these had been treated with asbestos paint, whilst the other one was quite unprotected. The other pair of erections were open timber sheds, about 6 feet square, and 8 feet high, one painted with asbestos, and the other not. These four erections were, by means of shavings, naphtha, and other combustibles, ignited at the same instant. Those which were unprotected by the fireproof medium, were reduced to ashes in about twelve minutes, the roofs and framework falling in with a crash, as they would have done in an ordinary conflagration. For half-an-hour the painted structures withstood the action of the flames, when the experiment was terminated. A pair of steps which had remained right above the bonfire of shavings remained uninjured even to the ropes, for it bore the stamping of a heavy man afterwards.

It may be mentioned in this connection, that there are several chemical salts, which, applied to fabrics, will prevent them burning. Of these, the tungstate of soda is, perhaps, the most effectual. We may also call attention to a fireproof varnish or paint, the formulæ of which has lately been published in France. It will be seen that asbestos does not enter into its composition. It consists of finely powdered glass, 20; porcelain, 20; stone of any kind, 20; and calcined lime, 10 parts. These ingredients, all in a pulverized condition, are mixed to a proper consistency with water glass (*i.e.*, silicate of soda). It is claimed that two coats of this mixture will prove a thorough protection to woodwork.

Strange Life Assurance Story. — Mr. Joseph Francis, author of "The History of the Bank of England," and other works, tells us that there was once a life assurance company which altogether omitted the usual prescriptive condition of rendering the assurance void in the event of the person who had assured his life committing suicide. A man who had opened a policy with this company invited the directors and his creditors to dine with him, and when the cloth was removed arose and said: "Gentlemen, it is fit you should know each other. These gentlemen are directors of the company in which I have assured my life. These poor honest men are the tradesmen to whom I am deeply in debt. I now mean—with your assistance, gentlemen—to pay them." As he spoke he pulled out a pistol, placed its mouth to his head, and blew his brains out.

A RIDE ON THE WIND.

IN the afternoon of Monday, July 25th, 1768, an extraordinary gust of wind near Cleobury Mortimer, in Shropshire, not only unroofed the dwelling-house, barns, stables, and out-buildings belonging to a farmer named Bishop (levelling one of the buildings with the ground, and tearing up and rending more than sixty apple and pear trees), but also took up his son, a youth of sixteen, and carried him at a height of four or five yards from the ground to a distance of about eight yards, over a stone wall, fish-pond, and a hedge, depositing him in a great state of terror, but otherwise unhurt, in a field of hay.

DECORATIVE MUTILATIONS.

AMONGST all the forms of personal adornment adopted by barbarous tribes, none are more repulsive than those frequent examples of mutilation mentioned by travellers in all countries.

We have already described (page 45) the extraordinary practice of tattooing, but this is only one out of many forms of personal disfigurement. In nearly every country, even in our own, the inhabitants are accustomed to pierce the ears for the insertion of pendent rings. In some places, however, this practice is carried to a great extreme, and amongst the Nagas, Kukis, and other Indian hill tribes, the lobe of the ear is pierced, and a plug of wood inserted, the size of which is gradually increased until at length a silver ring, about the size and nearly the shape of a napkin-ring (for which the writer has seen them used by Europeans) can be inserted, the extended lobe of the ear encircling the ring like a rope. Nose rings, too, are of frequent occurrence amongst savages, whilst many of the women of India, both Hindus and Mohammedans, are accustomed to pierce a small hole in one nostril, into which a stud of varying dimensions, sometimes of brass, sometimes of gold and gems, is inserted. The Sachet Indians of North America wear large pieces of wood or bone in a hole piercing the cartilage of the nose, and the Classet Indians slit, or otherwise disfigure their noses after having been successful in capturing a whale.

A more curious form of mutilation than any of these is, however, very common amongst many American tribes, and is not unknown in the Old World. This consists in the artificial deformation of the skull by constant pressure during infancy, and from this custom one tribe at least of American Indians, the Flatheads, has derived its name. The same custom is found in Mexico and Peru, in the Carib Islands and in Oregon, as well as in many other parts of the American continent, and history informs us that on the shores of the Euxine dwelt a race of Macrocephali, whose elongated heads were the result of artificial pressure. The direction in which this pressure was applied varied greatly amongst different tribes. The Natchez Indians produced an upward elongation of the cranium, terminating in a kind of point or edge, while the children of the Choctaws were laid upon a plank, and a bag of sand placed upon the forehead, "which," says Schoolcraft, "by continual gentle compressure, gives the forehead somewhat the form of a brick from the temple upwards, and by these means they have high and lofty foreheads sloping off backwards." Sometimes the head is bandaged between two boards (Fig. 1), but whatever means are adopted, the result is always the same—the production of a malformation of the skull, which is anything but prepossessing to the majority of mankind.

The manner in which the feet of Chinese ladies of superior rank are deformed and dwarfed by a somewhat similar process of bandaging is so well known, that it is only necessary to refer to it as one amongst the many forms of decorative mutilation.

Amongst the Eskimos the most fashionable ornaments are "cheek-studs" of wood or bone. These are worn either in the cheeks or in the lower lip, the hole into which they are inserted being formed in infancy, and gradually enlarged by the insertion of a series of "guides." These unseemly decorations are stated by Richardson to be in vogue amongst the natives from Behring's Straits to the Mackenzie River, but they appear to be confined entirely to the men.

The insertion of these studs into the lower lip calls to mind the custom of the Babines, who dwell to the north of the Columbia River. A large under lip being regarded as a type of beauty, a small incision is made in it during infancy, and a fragment of bone inserted. This is replaced from time to time by larger and larger fragments, each operation being productive of severe pain, and at length pieces of wood, measuring no less than three inches in length and an inch and a half in width, are inserted, "causing the lip to protrude to a frightful extent." A similar custom existed amongst the Paraguay Indians, who inserted a piece of wood four or five inches long into the lip, where it remained ever afterwards without removal. The labrets worn by the Botocudos (Fig. 2), some of whom were lately exhibited in London, are often two or three inches in diameter, and are inserted in a slit made in the lower lip; and it is from this custom that they have received their name, the Portuguese having compared the circular plug of wood to a *botoque*, or bung. A large disc will also be seen inserted in the ear, after the manner of the Nagas.

One of the most extraordinary freaks of fashion is, however, the practice of filing, piercing, or otherwise mutilating the teeth. Injurious as it might be supposed such a custom must be, it is, nevertheless, one of very considerable distribution amongst the barbarians of both the Old and the New World. Many of the North American tribes, and some of those of Australia, file the front teeth into various forms, and certain African tribes chip and grind the incisors, each tribe apparently following a different pattern or fashion of its own.

Still more extraordinary is the custom exhibited by a Dyak skull from Borneo, in which each of the six upper incisors has been carefully drilled with a small hole, into which was inserted a small metal pin, having a spherical polished brass head. These little metal knobs shine and sparkle when the mouth is opened, and are regarded as highly ornamental. Much has been said by ethnologists relative to this custom amongst the uncivilised people of the Old World; but practices of the same character, to be met with in North and South America, at the period of the Spanish discovery, have scarcely obtained more than a passing notice. Even Mr. von Ihering, who has so minutely detailed the various tooth mutilations indulged in by the Malays and other Eastern races, has hardly mentioned the custom prevalent in Peru of extracting the front teeth, noticed by many authors, from Cieza de Leon to Barnard Davis; nor does he refer to the custom of sharpening the incisors, observed by Tschudi and other travellers in Brazil and the Isthmus of Panama.

Fig. 1.—INDIANS WITH FLATTENED SKULLS, FROM THE LOWER FRASER, WITH CHILD IN THE CRADLE UNDERGOING THE PROCESS.

It sees, indeed, tolerably clear that the practice of artificially shaping the incisor teeth was one which was held in no very great esteem in America; yet Vancouver mentions that the Indians of the Bay of Trinidad, both men and women, were in the habit of filing the teeth almost level with the gums, the women carrying the practice to an even greater extent than the men. Amongst the Tchigt Eskimos, who dwell at the mouths of the Mackenzie and Anderson Rivers, a somewhat similar custom was observed by Mr. Petitot, while dental mutilations seem to have been formerly widely customary in Mexico and Yucatan, and have been described in detail by Sahagun, Landa, and Mota Podilla. Thus Diego di Landa, who wrote during the latter half of the sixteenth century, describes the Indians of Yucatan as filing the teeth to a sharp point, resembling the teeth of a saw, which they regard as highly becoming. The operation was usually performed by the old women of the tribe, by means of a hard grinding-stone and a plentiful application of water.

Mota Podilla, shortly after the Spanish conquest, observed a similar practice in the province of Panuco, where not only did the Indians file the teeth to sharp points, but also bored holes in them, which they stopped with a hard black cement. This double mutilation had, however, already been noticed by Sahagun as characteristic of the Huaxtecs, a race supposed to be the direct ancestors of the Pantecs of Mota Podilla, and originally forming a part of the great Toltec nation. And ultimately it was proved by the researches of Doutrelaine, in 1865, that the custom was one which had been in existence amongst the Toltecs from time immemorial. For in the curious ancient Toltec cemetery known by the name of the Cerro de las Palmas, was discovered a skull showing precisely the same mutilations of the incisors and canines of the lower jaw previously described by Sahagun. The teeth have been filed at their edges with the aid of a hard cylindrical tool, and the filed surfaces are neatly rounded and polished, the gaps thus produced measuring from two to four millimetres in depth. No less than six skulls thus disfigured have been obtained from this cemetery, while a skull which has recently been discovered in a Huaxtec place of sepulture, of a date anterior to the Spanish conquest, clearly proves, as regards the sharpening of the teeth, the exactness of the descriptions recorded by Sahagun and Mota Podilla.

Fig. 2.—BOTOCUDO INDIAN.

The excavations executed in the ruins of Tijar, near Medellin, have, however, brought to light a most interesting fragment of the head of a *terra cotta* statuette, in which are seen combined the flattened skull of the Toltecs and the dental perforations attributed by Sahagun to the Huaxtecs. In this curious relic, of which a figure is given in Fig. 3, the mouth is half open, and the upper incisors are shown perforated by regular cylindrical holes, about three millimetres in diameter and about one millimetre in depth.

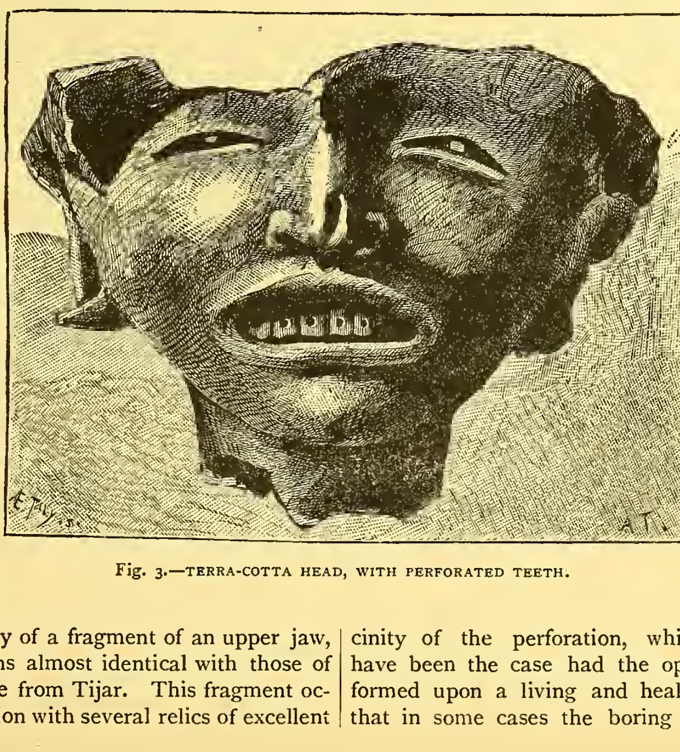


Fig. 3.—TERRA-COTTA HEAD, WITH PERFORATED TEETH.

Other excavations made in the State of Campeachy, during the French occupation, have led to the discovery of a fragment of an upper jaw, showing mutilations almost identical with those of the *terra-cotta* face from Tijar. This fragment occurred, in association with several relics of excellent workmanship, in a tomb in the neighbourhood of Campeachy, and though it would be hazardous to attempt to fix the date of this burial-place, there can be no doubt that it was anterior to the Spanish conquest. As may be seen in Fig. 4, (No. 1), the incisors and canines are skilfully bored near the centre by small holes about three millimetres in diameter, into which have been inserted small fragments of a hard stone of bluish colour, termed turquoises by Dr. Fuzier. The outer or exposed portion of these stones is regularly convex, and has received a tolerably high polish. Two of the stones have disappeared from their cells (those of the right canine and the left middle incisor), and it is seen that the perforations, which in these two teeth have attained a depth of one millimetre, have been produced by a drill similar to those which we know were used throughout this region anterior to the conquest, for boring diorite, serpentine, and *chalchinitl*, or rock crystal. The boring of even so slight a puncture, by means of this small drill, working in a bed of finely-powdered flint, must have occupied no inconsiderable time, and a careful examination of Dr. Fuzier's specimen shows that it has been performed after death, there being not the slightest trace of any pathological change in the vicinity of the perforation, which would hardly have been the case had the operation been performed upon a living and healthy subject. But that in some cases the boring was made in the teeth of living individuals does not admit of question, and whether practised upon the living or the dead, the mutilation is strikingly similar at Tijar and at Campeachy, amongst the ancient Huaxtecs and the Mayas ; and this resemblance has led to the belief in the original unity of the two races. A trifling ethnographical character such as this is, however, by no means sufficient upon which to base an argument as to the descent of nations. Nevertheless, it may be mentioned that the languages of these people presented some striking affinities, and are stated, with the language of the Quichas, to form one great lingual family.

We have little knowledge as to the customs of the other ancient inhabitants of Mexico and Yucatan, at least as regards the practice of boring and mutilating the teeth ; but M. Eugene Boban discovered at Tepito, in the valley of Mexico, an

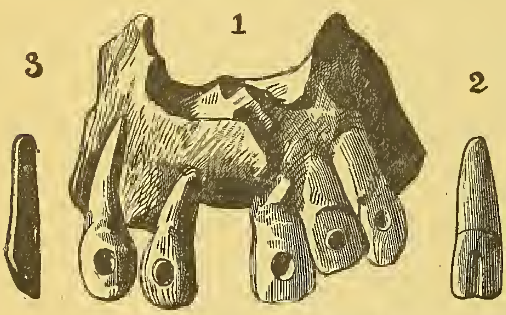


Fig. 4.—TEETH FROM CAMPEACHY.

Aztec relic, composed of a number of gold teeth, only one of which seems to have been preserved. This is also shown in Fig. 4 (Nos. 2 and 3), and indicates a custom of fluting or grooving the teeth, not dissimilar to that prevalent at Cabinda, in West Africa, where the natives file a deep notch in the middle upper incisors. From the examples of tooth mutilation which have come to our notice in various parts of America, it would be reasonable to infer that, if not very generally followed, it was, nevertheless, a custom of very wide distribution ; but though in a few places the fashion still remains, it is curious to observe that no traces of the custom are to be met with amongst the existing races of Mexico and Yucatan.

Many other forms of mutilation, practised either as decorative or ceremonial, might be described if space permitted. But enough has been said to show that the propensity is a curiously general one, common in some form or other to a large proportion of the primitive races of mankind. It is, in fact, one of the peculiarities which are distinctively *human;* and why the human mind should persist in outraging nature, whether by spoiling teeth or by tight-lacing, might furnish curious subject for speculation.

THE ULTIMATE MYSTERY.

We have now shortly, and in a popular manner, considered the elements of Matter and their methods of combination ; also the all-pervading Energy which affects them, and its wonderful changes. Wonderful as they are, we have so far found these conceptions apparently pretty simple ; but this is because they represent to us merely methods and phenomena. The human intellect, however, refuses to rest satisfied with these : it persists in asking, What is the ultimate, or real nature of things ? Such questions occupied and puzzled the great thinkers of antiquity. Since then science has professed to discard their modes of inquiry as barren, and to substitute for them exact experiment and research ; but it is remarkable that, when we have carried these as far as they will go, we have to return to the old methods, and are confronted with the same insoluble difficulties which have ever baffled the human mind.

First of all, that Energy which we have considered must obviously have some medium for its action—or, if we like to call it so, for its conveyance. Observing motion, for instance, we see that one billiard ball does not transfer its motion to another until it knocks up against it ; till then the second ball is unaffected. Wave-motion also, of any kind, requires a medium in which to propagate the wave ; and so, when Roemer found that the light of one of Jupiter's emerging satellites took a quarter of an hour to cross the earth's orbit, it was plain that *something*, or motion in something, traversed at a definite rate that apparently immense void. Later on, the remarkable phenomena of polarisation showed that the vibrations whose wave-propagation constitute light required to be made *across* the path of the ray ; and it was seen at once that this necessarily involved further, something of the constitution of a solid body, since no fluid is capable of propagating such waves.* Tremors must be transmitted through the medium which conveyed Light, whatever it was, somewhat as through a jelly ! Here at once, then, physicists were and are confronted with apparently contradictory requirements. The Ether, as this universal medium is called, must be unimaginably rare and subtle, since it passes through *all* matter freely, and does not perceptibly obstruct the heavenly bodies ; yet it must have the chief distinguishing property of a solid ! More than this, its elasticity, or resilience, must be literally inconceivable to us. We can neither see it, nor feel it, nor weigh it ; its necessary properties seem in their contradiction to mock all our faculties ; yet we must suppose it, or something like it, or *all* our physical theories fail us,

* It is true that transverse motions are transmitted by waves on the surface of water. But we are considering vibrations *in* or through a medium, not on a bounding surface of it.

and our known facts fall to the ground as a confused mass.

The Ether may seem unreal and far away; but we fare no better when we consider that Energy which appears so near, or even the Matter which seems so tangible to us. To the chemist, his ultimate atoms necessarily appear absolutely hard, or inelastic; for if they were elastic, elasticity implies alteration in the position of *parts*, and these parts would to him be smaller particles. But the physicist's theory of gases which we have briefly described, supposing as it does atoms flying about with a speed which constitutes the temperature and elastic force of the gas, and rebounding from each other without loss of energy or increase of temperature, equally necessitates perfect elasticity. It was chiefly to reconcile these contradictory requirements that Sir William Thomson, carrying farther some ideas of Helmholtz, framed his celebrated Vortex Theory of atoms. We have seen (p. 52) how vortex rings of air made visible by smoke (and the smoke has really nothing else to do with it) retain their identity even all across a room. Now the remarkable thing about them is, that although they really do consist of small molecules of air, these molecules are so *bound together in the vortex ring*, that it is the very *same* molecules which travel along. They are so tied that we cannot separate them; even a knife cannot cut a vortex-ring in two, but the ring recoils from it; and two vortex-rings *recoil from each other* like two elastic bodies. It is true that such air-rings disperse at last, but that is because even the air has friction; and both Helmholtz and Thomson have shown that if we had a perfectly *frictionless* fluid—either liquid or gaseous—a vortex-ring once formed in it could never be destroyed, but must go on for ever! On the other hand, in such a frictionless fluid we could never *make* a vortex-ring. We made our air-rings by friction itself; but in a perfect fluid, to make vortices would require a Creative act. Thomson and others therefore suppose that the Ether may be such a perfect fluid, and that inconceivably small Vortices in it may be the Atoms of Matter which we know. While we can only by our rough methods make simple rings, such vortices might be knotted on themselves in all sorts of ways, so accounting in some fashion for the differing "elements" of matter; and the elastic vibrations of such rings might account for the various lines of the spectrum of the gaseous elements, and for various other phenomena.

On the whole, this theory accounts for more phenomena than any other which has yet been framed, and therefore receives more adherents every day; yet it presents almost insuperable difficulties of its own. In the first place, it is doubtful if vortices in a perfect fluid would "stand out" from the medium so distinctly as matter does. In the second place, the wonderful force of chemical affinity between different elements (or forms of vortices) is unaccounted for. But chiefly the grand difficulty remains, that the constitution of a fluid, as we know a fluid, cannot belong to the ether, for reasons already given. The only way to remove this last difficulty is to suppose that the ether combines the properties of a fluid and of a solid—of perfect mobility with perfect fixedness—in some constitution of which we have no experience and can form no conception. This is therefore supposed; but it leaves the ultimate, primal Ether, which thus becomes the source of all things, more inconceivable and mysterious than ever.

And our conceptions as to the absolute reality or nature of things are equally baffled in matters much more near and apparently tangible to us than these. We are obliged to conceive of Energy as something quite distinct from Matter; for we can deprive matter of almost any *form* of energy, apparently leaving the matter otherwise unaffected. A moving ball will yield up its motion to another ball. One ball has acquired motion, and the other lost it; but both *balls* remain otherwise the same. The motion itself has been visibly detached and *transferred*, as it were. This is itself a profound mystery; for why *should* what we call "dead matter" transfer motion to other dead matter? But when we begin to think, we further find that we never know either Force or Energy except in connection with matter. We know *moving bodies*: pure motion itself we know nothing of. And yet the body through which alone we can know or experience the motion, can somehow get rid of it, by handing it over to some other body.

Even Matter itself equally eludes our comprehension, whatever it may be. We think we can at least conceive of that, as something "real," distinct from motion or other forms of energy. Let us try. It must have no colour, or be at all visible, for Light is a form of Motion. It cannot feel warm, nor yet cold; for both these feelings are transfers of motion. Of course it cannot move. It has no magnetic, nor electric, nor chemical properties; it has no weight, which is a consequence of attractive force; it can give us no feeling of resistance, for even that is a manifestation of force! Now when we have come to that, *what has become of our matter?*

So profoundly true is this, that Boscovitch, Faraday, and many others, believed each ultimate atom to be but *a centre of forces*, from which somehow forces *were* exerted, no one could tell why or how. Professor Tyndall states Faraday's view (not his own) in this way. "What do we know of the atom apart from its force? You imagine a nucleus which may be called *a*, and surround it by forces which may be called *m*; to my mind the *a*, or nucleus, vanishes, and the substance consists of the powers of *m*. And indeed, what notion can we form of the nucleus independent of its powers?" Very many take that view, and it is as likely to be true as any view; but it helps us no more than the other. What the intellect strives for is something *constant*, something that remains amid all changes and transformations; something that *is*. Now we have found already that if this something be motion, in some mode or form, we cannot conceive of it without something else that is moved. Nay, we soon find that there can be nothing absolute about motion at all; this is a very old discovery among thinking men. To repeat an illustration almost as old as the hills, take a man on board a ship. He is motionless as regards the ship, but he *moves* over the surface of the earth. Conceive that the ship moves from east to west at the same speed as the earth's surface revolves from west to east; he is again without motion as regards a point in the heavens. But the earth also moves round the sun: shall we say the man now moves in a circular orbit? The sun also rushes through space; and so we may go on, finding at every step that motion is not absolute but relative, and that the motion of any body is no more than change of place *in relation to some other body*. We can only imagine "absolute" motion at all, by supposing space itself—mere space—to be itself an absolute and real thing, with finite dimensions, and with fixed points in it to which motion can be referred. And any such notion of empty space is as inconceivable as the rest.

Weight itself presents the same difficulties. Our most tangible notion of matter is, that it has weight; we seem to hang on to that amid all our perplexities. But that too is relative, depending altogether upon the attraction of gravitation—itself an inscrutable mystery—between it and *some other body*, in our case the earth. A 1 lb. weight would "weigh" only 2 oz. on the moon, and 27 lb. on the sun; and if there were no other piece of matter in the universe but this 1 lb. weight, it could have no weight at all!

Thus we find ourselves baffled on every side. And this may perhaps teach us the true nature of all such difficulties. It appears that our intellectual constitution is incapable of conceiving absolute ideas. Take time itself: we cannot conceive of its ever having a beginning, neither can we think of its having none; and the same as to any end or termination; while yet it seems as if there must be one or the other. We are equally unable either to frame or conceive any absolute measure of time; all our measures depend on the relative movements of bodies, which we have already found to be destitute of any uniform standard. We cannot conceive of a Universe boundless in space, and it is as difficult to imagine any boundary. We cannot conceive of things having always existed; neither can we of their having begun to be, anyhow. We may scoff at these questions as vague discussions of the metaphysician; but the difficulties and contradictions in every theory we can frame—and we have only mentioned a very few of them—make us feel that, with all the boasted definiteness and exact knowledge of physical science, her votaries are at last as helpless as he. We cannot apprehend the essential nature of that wondrous trinity of Ether, Matter, and Energy, so strangely distinct and yet so strangely united, which even the material Universe presses upon us on every hand.

While, however, this inability should teach us humility, we must on the other hand avoid a mistake some philosophers have made, and not lay disproportionate stress upon the extent and inaccessibility of the Unknowable. We have found that this meets us, at last, in the physical as much as in the moral and spiritual domain. But in the one, as in the other, if we cannot know all, it is not in the least true that we can know nothing. The Absolute may refuse to reveal itself to us; but none the less, the relations between its various modes or forms, and their relations to our own being, are not only open to our investigation, but can be known more or less completely. The knowledge we can acquire, if not complete, is *real* knowledge, so far as it goes. The Undulatory Theory of Light and the Atomic Theory of Matter may possibly one day be superseded by better theories even of the phenomena they deal with; but none the less they will have contained *something* answering more or less to the truth, and which will be represented in any newer or better theory which replaces them. Our bodily eyes may possess neither the powers of the microscope nor of the telescope; but they are notwithstanding, in their measure, true witnesses, though there be tasks that lie beyond them, or which they can only perform when aided by further powers. Some day, with extended faculties, all that now seems so inconceivable may appear wonderfully simple and beautiful; but however that may be, and whatever increase of its powers may be in store for the human mind in a future and more perfect state, one of whose grand and mysterious promises is that we shall "know," even in the meantime all finite relations of the Unknowable are open to our search, and the constitution bestowed upon us urges us irresistibly to push inquiry to its farthest limits. We are not debarred from either knowledge or belief, because in proportion as we approach the Absolute or the Infinite we come face to face with the Inscrutable.